

Light and **LIGHTING**

SEPTEMBER, 1954 PRICE 25s.



OPTICAL SCIENCE

By controlling the distribution of light within strict, predetermined limits, HOLOPHANE refractors and reflectors provide the ideally flexible medium for modern street lighting projects, for both Group 'A' and 'B' roads. HOLOPHANE units are constructed to unique prismatic designs fully controlling the lamp output and embodying detailed optical research of HOLOPHANE scientists for over sixty years. Please write for details of the complete range of HOLOPHANE street lighting or see STAND 20 A.P.L.E. CONFERENCE, HARROGATE.

IN STREET LIGHTING

HOLOPHANE LIMITED

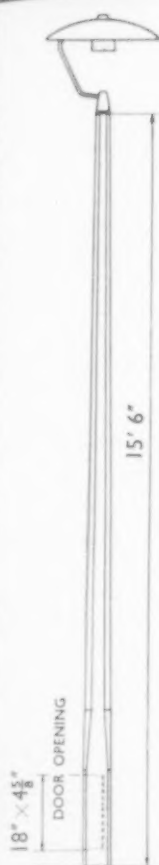
SCIENTIFIC ILLUMINATING ENGINEERS

ELVERTON STREET, WESTMINSTER, LONDON, S.W.1
Phone: VICTORIA 8062, Grams: Holophane, Sowest, London



STANTON

Prestressed Spun Concrete Lighting Columns



Our photograph illustrates the slender appearance of the No. 10 column designed for Group 'B' lighting.

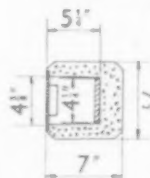
The type shown is part of a wide range of Stanton designs approved by the Council of Industrial Design.

For further information please telephone Ilkeston 86 Extension 44 or write Lighting Column Sales Department.

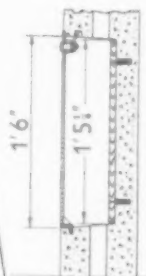
No. 10

APPROXIMATE WEIGHT
OF COLUMN: 4 CWT. 52 lb.

Plastic door (Polyester Resin
Glass Fibre) with Yale Type
Lock and Universal Key



Section through
centre of door box



MAIN PRODUCTS

PIG IRON
FOUNDRY, BASIC
AND REFINED

CAST IRON
PIPES AND SPECIAL CASTINGS
GENERAL CASTINGS
TUNNEL SEGMENTS

SLAG
TREATED AND DRY
HOT AND COLD ASPHALT

CORE OVEN BY-PRODUCTS

BRICKS

CONCRETE
PIPES AND MANHOLES
LIGHTING COLUMNS
PAVING FLAGS
GENERAL PURPOSE SHEDS

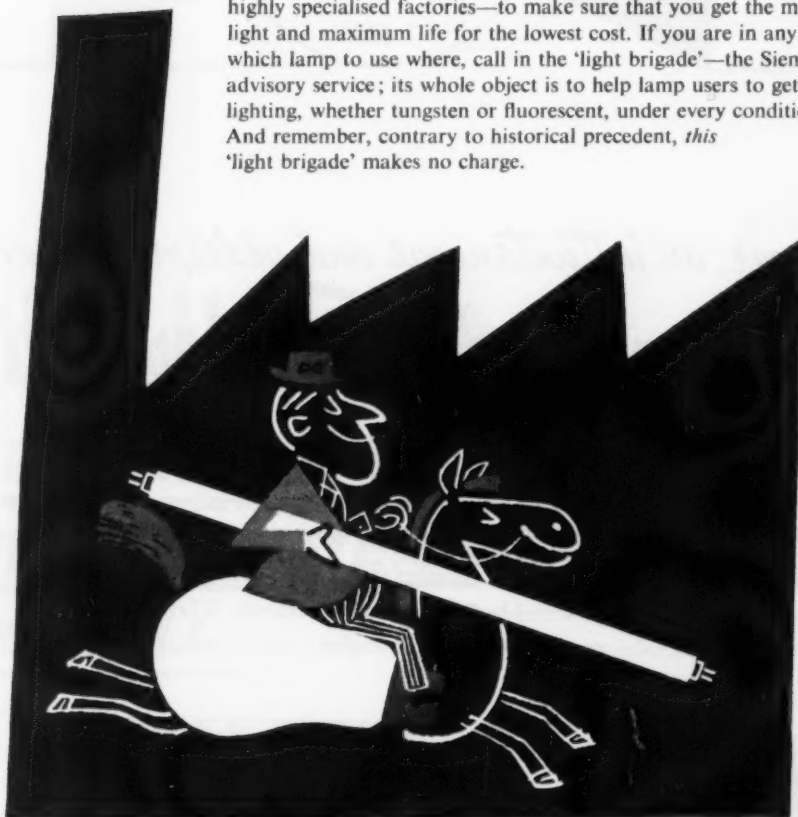
PRESTRESSED CONCRETE
PRESSURE PIPES
LIGHTING COLUMNS



THE STANTON IRONWORKS COMPANY LIMITED NEAR NOTTINGHAM ENGLAND

Have you got the right lamps— in the right places?

In the very wide range of Siemens Ediswan lamps there is a 'best' type, size and power of lamp for every place and every purpose. It usually costs no more—and may often cost less—to fit the correct Siemens Ediswan lamp than to put up with a lamp or a fitting that is 'near enough'. Siemens Ediswan lamps are manufactured on highly specialised machines—and in highly specialised factories—to make sure that you get the maximum light and maximum life for the lowest cost. If you are in any doubt about which lamp to use where, call in the 'light brigade'—the Siemens Ediswan advisory service; its whole object is to help lamp users to get the best lighting, whether tungsten or fluorescent, under every condition. And remember, contrary to historical precedent, *this* 'light brigade' makes no charge.



call in the 'light brigade' from



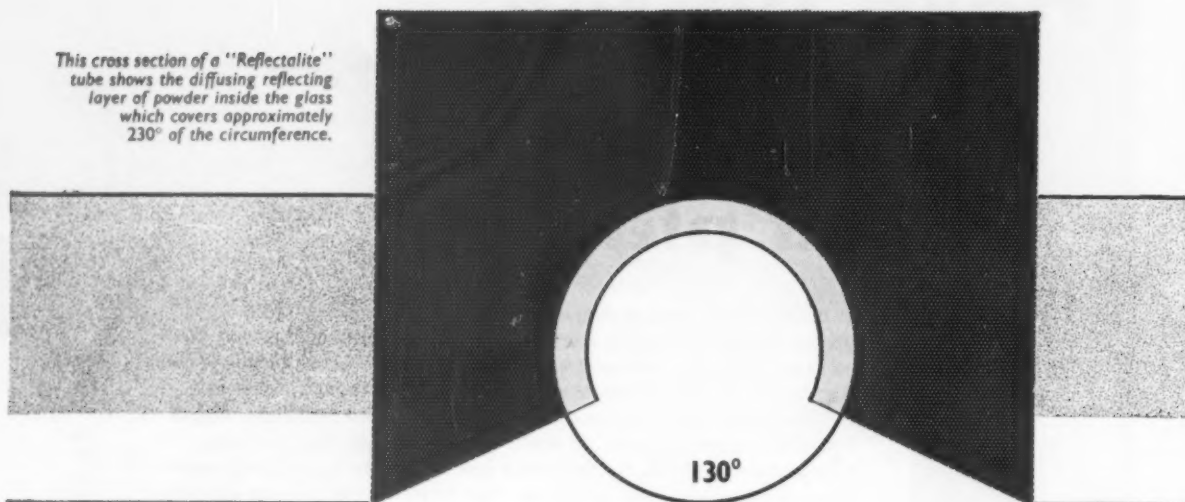
SIEMENS EDISON SWAN LTD. AN A.E.I. COMPANY

Lamps and Lighting Division, 38/39 Upper Thames Street, E.C.4, and branches. Telephone: CENTral 2332

CSC17/31

A

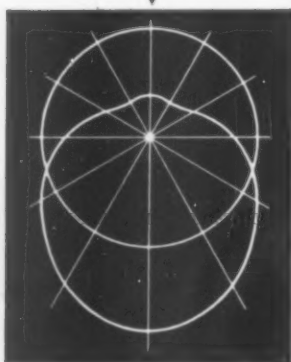
This cross section of a "Reflectalite" tube shows the diffusing reflecting layer of powder inside the glass which covers approximately 230° of the circumference.



Last year, an instantaneous and widespread success
This year PHILIPS Reflectalite

Here's news about PHILIPS "Reflectalite", the fluorescent tube with the built-in reflector. This year the light output of "Reflectalite" has been increased even further. For example, the 40w. Cool White tube now has 10% greater efficiency – so the "Reflectalite" sales appeal is now even stronger than before. This extra-effective sales story will be put across in powerful leaflets and advertisements. When your customers see them, sales are going to rise even higher – and so will *your profits!*

STANDARD LAMP



REFLECTALITE
 Light distribution
 comparison diagram.



Almost two-thirds of every "Reflectalite" tube is internally coated with a special powder prior to the application of the normal fluorescent phosphor. Thus the major part of the light output is reflected through the 130° 'window' where it has maximum effect.

REFLECTALITE 4' 40w. and 5' 80w. lamps are available for use on Switch-start or Instant-start apparatus in Warm White, Cool White and Cool White de Luxe colours. All 80w. tubes obtainable with B.C. or Bi-Pin caps.

LIST PRICES: Switch-start 4' 40w. 13/9 plus P.T.
 5' 80w. B.C. or Bi-Pin 14/9 plus P.T.
 Instant-start lamps 1/- extra.



has even more to offer!

This year you'll have

EVEN GREATER OPPORTUNITIES

TO SELL



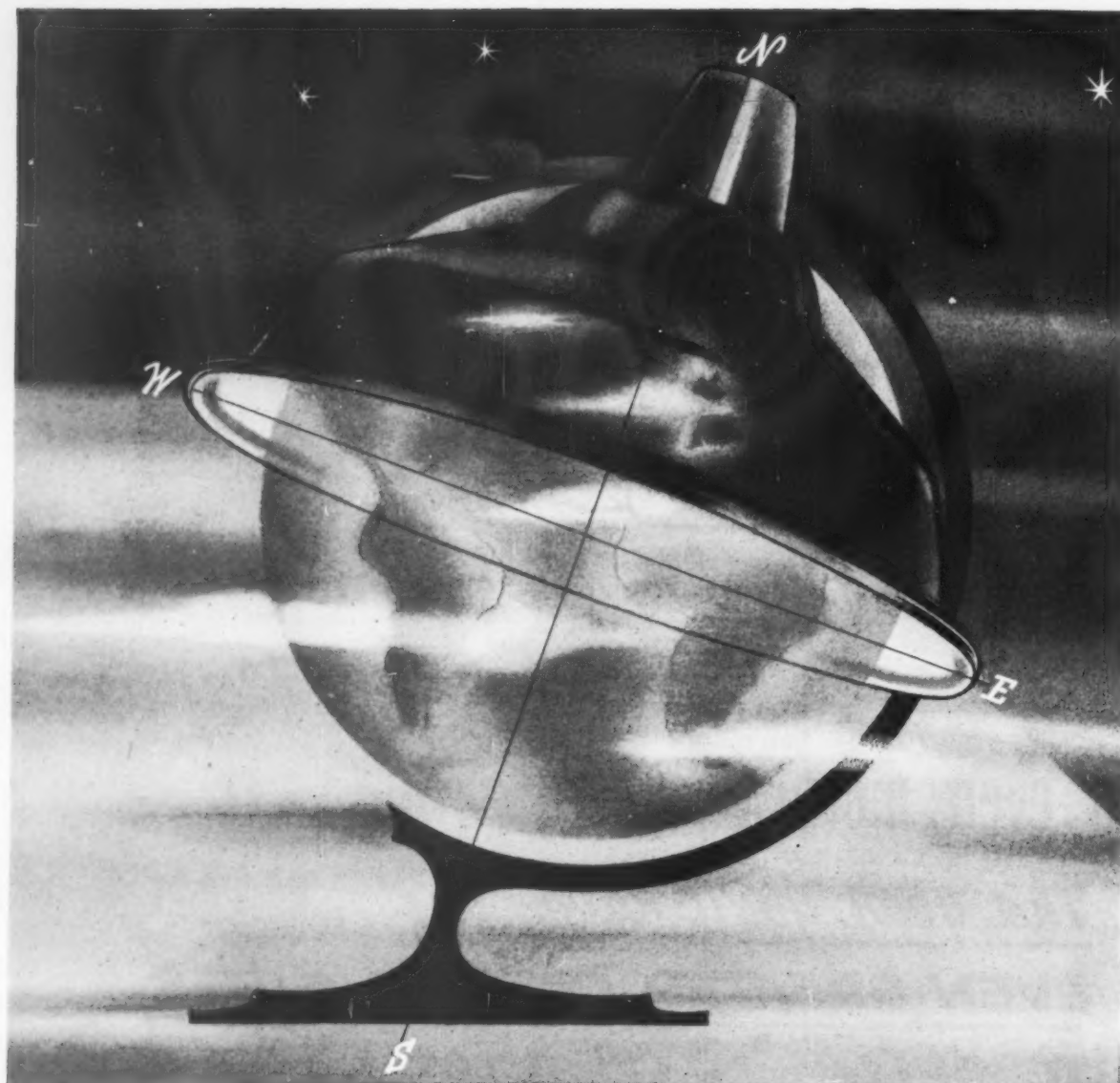
PHILIPS

Reflectalite

**FLUORESCENT
REFLECTOR
TUBE**

now with **INCREASED EFFICIENCY!**

PHILIPS ELECTRICAL LTD • LIGHTING DIVISION • CENTURY HOUSE • SHAFTESBURY AVENUE • LONDON • WC2



A word or two on illumination

A switch is pressed in the home . . . night shifts of Industry concentrate on intricate problems . . . across the globe hundreds of thousands of fans roar at floodlit soccer matches . . . ports and dockyards work on throughout the night. In these, and countless other ways, Benjamin Lighting Fittings are efficiently and reliably carrying out their tasks all over the world.

For 50 years The Benjamin Electric Ltd., one of the world's largest manufacturers of lighting fittings, have met the lighting needs of Industry, Commerce, Business and Sport with scientifically designed fittings. When you consult Benjamin, this wealth of experience, knowledge and technical ability is at your disposal.

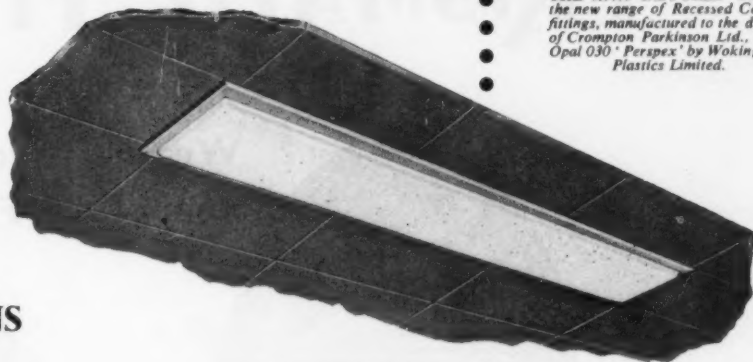


better lighting by **BENJAMIN**
REGD.

Wokingham Plastics



**SPECIALISTS
IN
ACRYLIC
MOULDINGS
AND
FABRICATIONS**



THE A.479 DIFFUSER—One of the new range of Recessed Ceiling fittings, manufactured to the design of Crompton Parkinson Ltd., from Opal 030 'Perspex' by Wokingham Plastics Limited.

**INTERIOR
or PUBLIC
LIGHTING
FITTINGS**

Specialization—the constant application of the finest technical knowledge and skill to the job in hand—is the answer to the need for lighting fittings that measure up to modern requirements of maximum dependability, plus fitness for purpose—and economy in costs. That is why the Wokingham Plastics Service is more and more in demand by those organisations whose reputation for efficiency is reflected in their choice of equipment.

May we serve you with the same certainty of your complete satisfaction? Get in touch with us NOW.



Revos C.14674 'Perspex' Canopy Bowl—manufactured in clear 'Perspex' with special moulded finish and two machined 'Perspex' prismatic plates sealed in inside. Manufactured by Wokingham Plastics Limited.

TELEPHONE :
WOKINGHAM 700/701

WOKINGHAM PLASTICS LTD

DENTON RD. WOKINGHAM BERKSHIRE

A.I.D. APPROVAL No. 5079/43
A.R.B. APPROVAL No. A1/4701/55

CONTRACTORS TO ADMIRALTY, AIR MINISTRY, POST OFFICE



*as always —
better than they have to be*

PRISMATIC FITTINGS

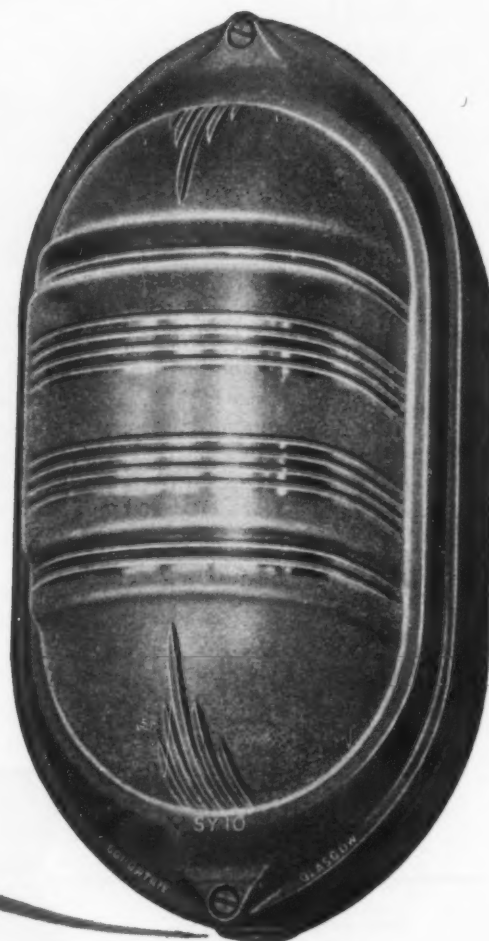
IN ALUMINIUM ALLOY

Weatherproof
Beautifully Finished

List No.
SY 6
60 watt



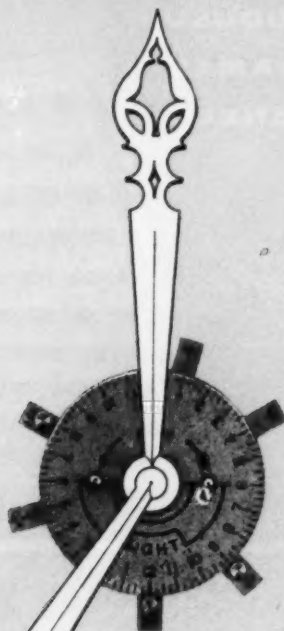
List No.
SY 10
100 watt



Manufactured at
**HILLINGTON
GLASGOW, S.W.2**

by **J. & G. COUGHTRIE Ltd.**
CATALOGUE AVAILABLE ON REQUEST

VENNER



Time Switches

Automation in street lighting and in industrial timing is not new. It has been developed over the last half century by the application of Venner Time Switches.

The uses of Time Switches to-day are too numerous to detail. It can only be said that your particular 'time' problem will be investigated and almost certainly solved if you ask our advice.

Time is our business

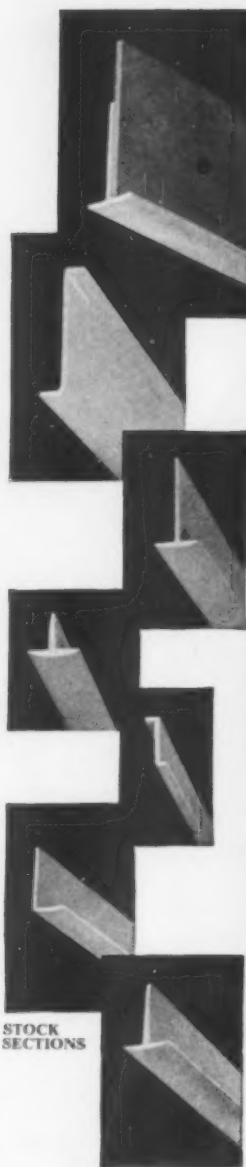
VENNER LIMITED • Kingston By-Pass • New Malden • Surrey

Associated Companies: Venner Accumulators Limited • Venner Electronics Limited

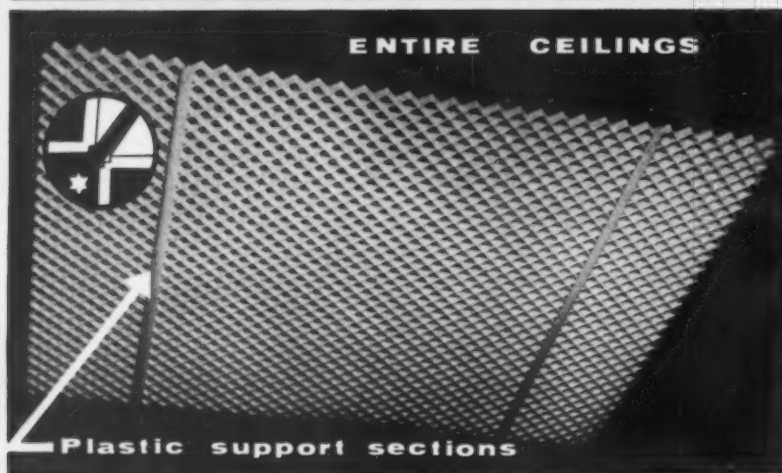
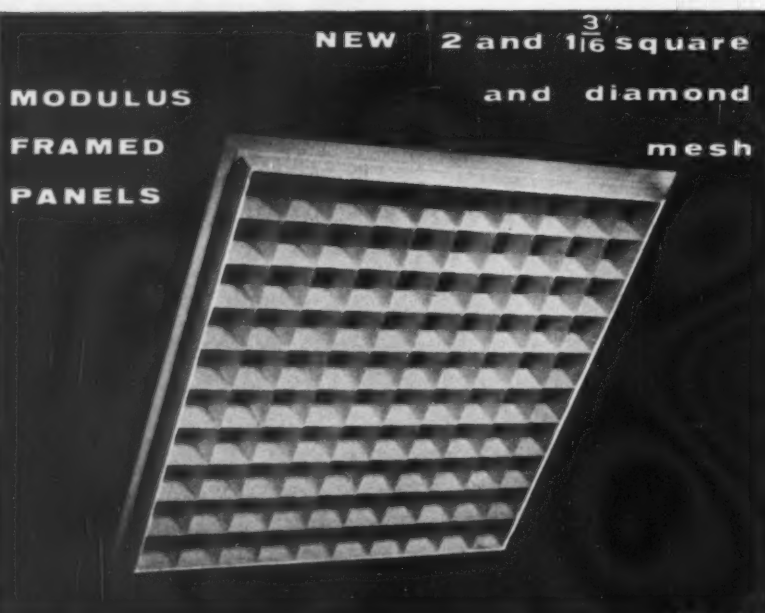
ELCOPLAS

Lighting Louvre

REG. DESIGN NO. 873594



STOCK SECTIONS



★ *The only plastic louvre fitted with the perfect interlock corners*

Additional extruded T and Z plastic support sections to enable large areas to be covered, reinforced 2" T section to enable wide span to be covered. Modulus panels, plain or framed, in sizes to suit all types of ceiling construction. Ask your ceiling contractor and lighting engineer for further details.

ELCO PLASTICS LTD.

HIGH WYCOMBE, BUCKINGHAMSHIRE

TELEPHONE: HIGH WYCOMBE 4111/2/3/4 (four lines)



S & L tubular steel lighting columns type Gb. 583 (single arm) and Gb. 591 (double arm)

TUBULAR STEEL LIGHTING COLUMNS

TO B.S. 1840-1952

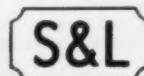
The lasting qualities and dependability of S & L tubular steel lighting columns—under all conditions of loading—have been abundantly proved over many years. Their slenderness and small base size present an unobtrusive and generally pleasing appearance and enables them to be used on most sites.

The columns are designed for a variety of outreaches and the bracket arms can be adapted to various types of lantern.

Delegates to the A.P.L.E. Conference, in addition to visiting our stands Nos. 6, 7 and 8, may wish to see the columns illustrated above. These were recently erected by the Harrogate Corporation at one of their roundabout sites.

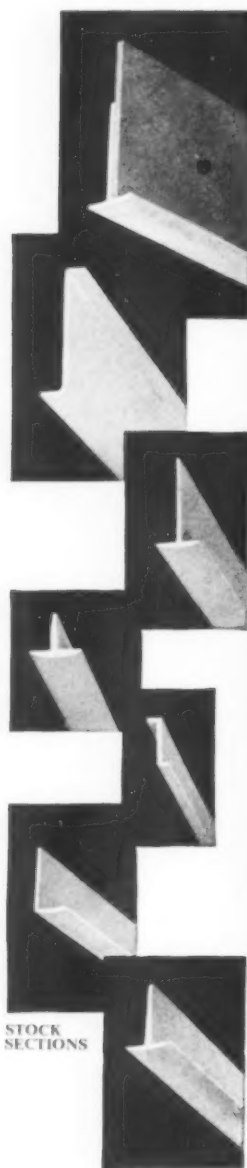
STEWARTS AND LLOYDS LIMITED

GLASGOW • BIRMINGHAM • LONDON

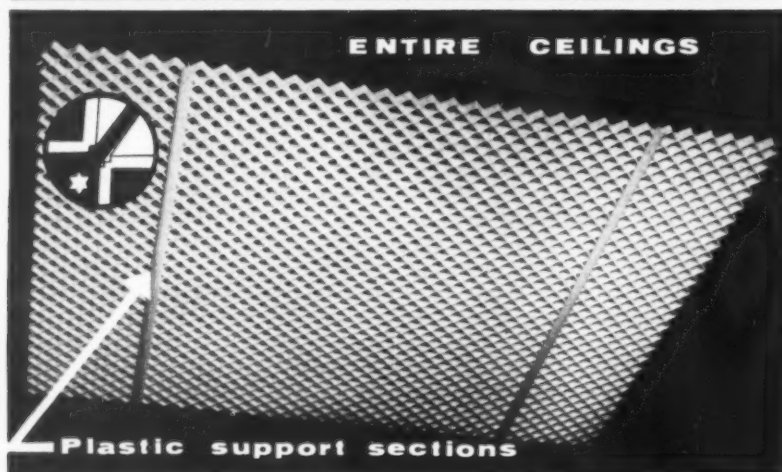
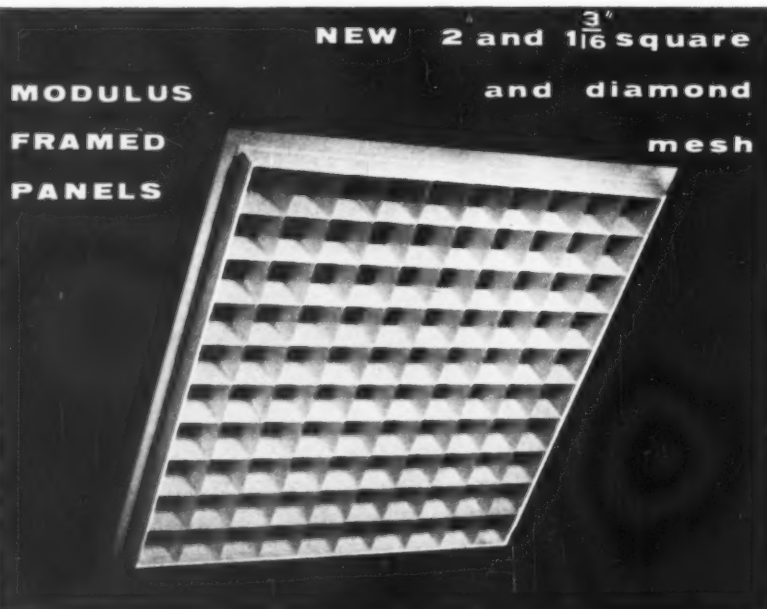


ELCOPLAS *Lighting Louvre*

REG. DESIGN NO. 873594



STOCK SECTIONS



★ *The only plastic louvre fitted with the perfect interlock corners*

Additional extruded T and Z plastic support sections to enable large areas to be covered, reinforced 2" T section to enable wide span to be covered. Modulus panels, plain or framed, in sizes to suit all types of ceiling construction. Ask your ceiling contractor and lighting engineer for further details.

ELCO PLASTICS LTD.

HIGH WYCOMBE, BUCKINGHAMSHIRE

TELEPHONE: HIGH WYCOMBE 4111/2/3/4 (four lines)



*S & L tubular steel lighting
columns type Gb. 583 (single
arm) and Gb. 591 (double arm)*

TUBULAR STEEL LIGHTING COLUMNS

TO B.S. 1840-1952

The lasting qualities and dependability of S & L tubular steel lighting columns—under all conditions of loading—have been abundantly proved over many years. Their slenderness and small base size present an unobtrusive and generally pleasing appearance and enables them to be used on most sites.

The columns are designed for a variety of outreaches and the bracket arms can be adapted to various types of lantern.

Delegates to the A.P.I.E. Conference, in addition to visiting our stands Nos. 6, 7 and 8, may wish to see the columns illustrated above. These were recently erected by the Harrogate Corporation at one of their roundabout sites.

STEWARTS AND LLOYDS LIMITED

GLASGOW • BIRMINGHAM • LONDON



A·E·I

Lamp and Lighting Co Ltd

adds the light touch



with a new range of
aluminium columns for
Group B roads. See them
on stands 1 and 2, A.P.L.E.

A.E.I. Lamp & Lighting Company Ltd
Lighting Department • Melton Road • Leicester

Cryselco - at your service everywhere



LEEDS THE CIVIC HALL In town or country, wherever you are, CRYSELCO'S national coverage ensures for you the best quality and prompt service for all your lamp and fittings requirements. There are branches waiting to serve you in fourteen towns and cities. Please write or telephone.

OVER SIXTY YEARS OF QUALITY AND SERVICE

CRYSELCO

MADE IN ENGLAND



OUR ILLUMINATING ENGINEERING DEPARTMENT
IS AVAILABLE TO GIVE CUSTOMERS PROMPT HELP AND SERVICE



Branches

BIRMINGHAM • BRISTOL • BURY ST EDMUNDS • CARDIFF • GLASGOW • LEEDS
LEICESTER • LIVERPOOL • LONDON • MANCHESTER • NEWCASTLE • NOTTINGHAM • SOUTHAMPTON



CRYSELCO LIMITED

KEMPSTON WORKS

BEDFORD

**The Largest and most experienced
designers and manufacturers
of Road Signs and equipment**



COMPANY

Road Traffic Signs, all finishes
Illuminated Guardposts
Tubular Steel Posts/Columns
Lighting Columns
Direction Arms
Approach and Route Direction Signs
Street Nameplates
Beacon Globes, Plastic
Steel Road Studs, Lines and Letters
Letters and Arrows—Plain or Reflex
Cast Iron Island Sites
External Lighting Fittings
Portable Signs
"Permaposts" P.V.C. sleeving for posts
Reflective Surface Signs



Head Office & Works

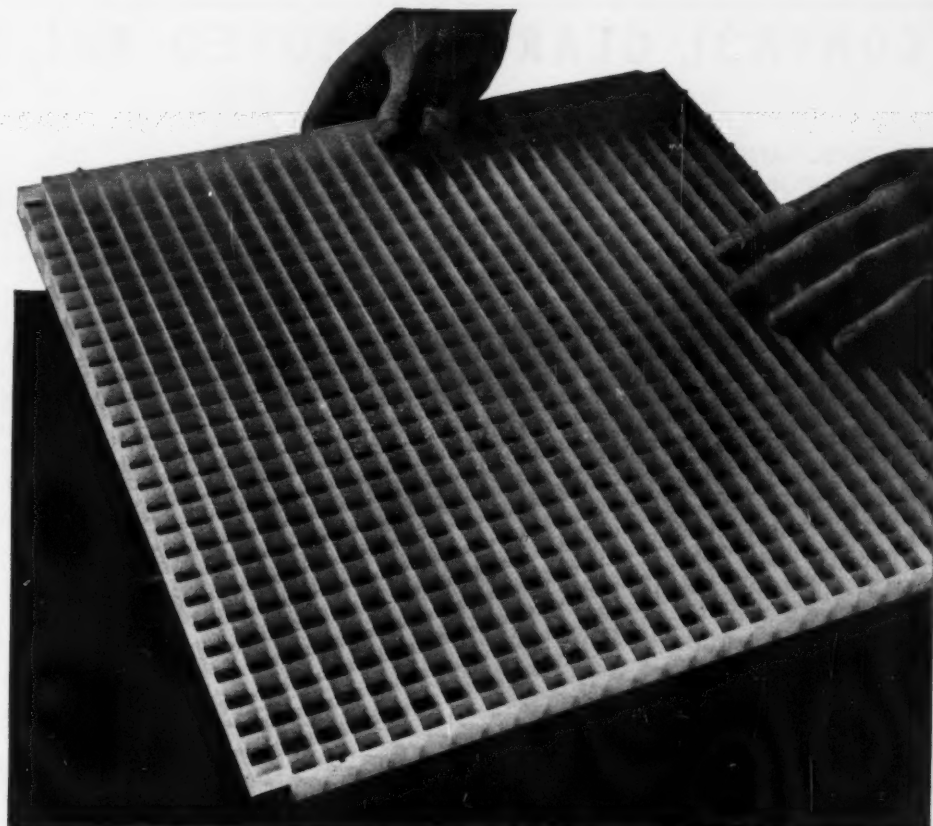
Rood End Road, Oldbury, Birmingham

Phone: BRoadwell 2291-2

London Office & Showrooms

Lambs Conduit Passage, Red Lion Square, W.C.1

Phone: CHAncery 7042 & 7845



Paragrid-tile

A NEW TYPE OF LUMINOUS CEILING UNIT

GOOD LIGHTING knows no frontiers but draws inspiration from good practice the world over. This wide outlook is typical of Harris & Sheldon, who introduced Luve-tile and Luveline to this country and are now again collaborating with Wilsons of Canada to produce Paragrid-tile, another superb tool for the lighting designer.

"Paragrid-tile" combines elegant appearance with superb luminous and diffusing qualities. The unique construction and slender proportions of the 16" x 16" polystyrene tile are clearly shown in the above photograph. The advantage of a louvered ceiling is maintained, yet at the same time the small sized cells give an appearance of a translucent diffusing panel.

** There is a Handslite lighting fitting for almost every lighting application, and we specialise in the design of fittings to suit individual requirements. Write for fully illustrated literature.*

HANDSLITE

THE BEST OF BOTH WORLDS

Harris & Sheldon (Electrical) Ltd.

RYDER STREET, BIRMINGHAM 4. Telephone: Central 6272
London Office: 46 GT. MARLBOROUGH STREET, W.1. Telephone: GERrard 0869

Complete Lighting Specialists and Manufacturers of Lighting Fittings and Control Gear

CONTROL GEAR OF PROVED RELIABILITY

THOUSANDS
UPON
THOUSANDS
IN
EVERYDAY USE
THROUGHOUT
THE
WORLD.

STANDARDIZED BY
LEADING MANUFACTURERS
FOR EVERY
DISCHARGE LAMP
FROM
6 W. to 3,000 W.
INCLUDING
SPECIALISTS' TYPES



CAYSON
ELECTRICS LTD.

MANUFACTURERS
OF LIGHTING FITTINGS
AND MACHINES USING
DISCHARGE LAMPS
ARE INVITED TO SEND
FOR
DETAILED CATALOGUE

**CAYSON
ELECTRICS LTD.
WATFORD**

WATFORD 7156 & 7177

London Office: ANGEL HOUSE, ANGEL, N.1 (TERminus 0566)

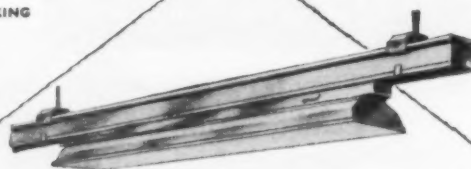
above all for complete adaptability

The patent SLYDA-LONG Lighting system provides for flexible lighting installation. Trunking is supplied in 12' 6" lengths complete with wiring clips at 12" intervals and 3-way 15 amp. Mains Connectors at 6' 0" intervals. Lighting Units may be removed or added to alter lighting layout without disturbing the mains wiring.

Write for new catalogue No. 1062

SLYDA-LONG TRUNKING

A typical illustration of 3,000 lampways of Thorlux high quality vitreous enamelled trough reflectors on SLYDA-LONG Trunking.



INDUSTRIAL LIGHTING EQUIPMENT

THORLUX

REGD.
THROWS LIGHT ON INDUSTRY

Manufactured by
F. W. THORPE LIMITED
Welby Road, Hall Green,
Birmingham, 28
Springfield 3318-19-10
Grams: THORLUX 8'ham





rotaflex the exciting lighting

A large selection of wall brackets, table and floor lamps, display fittings and shades
designed by John and Sylvia Reid A/RIBA M/MSIA FIES for industrial, commercial
and domestic use... A lighting service geared to the production of lighting fittings
for all special schemes. Send for your copy of the new Rotaflex catalogue.

* Rotaflex "Ovoid" won the 1957 Design-of-the-Year Award

ROTAFLEX (GREAT BRITAIN) LTD, SHOWROOM 4 CONDUIT STREET LONDON W1

G.E.C.

TAPERED THREE-EIGHTY LANTERN



**for
main
road
lighting**

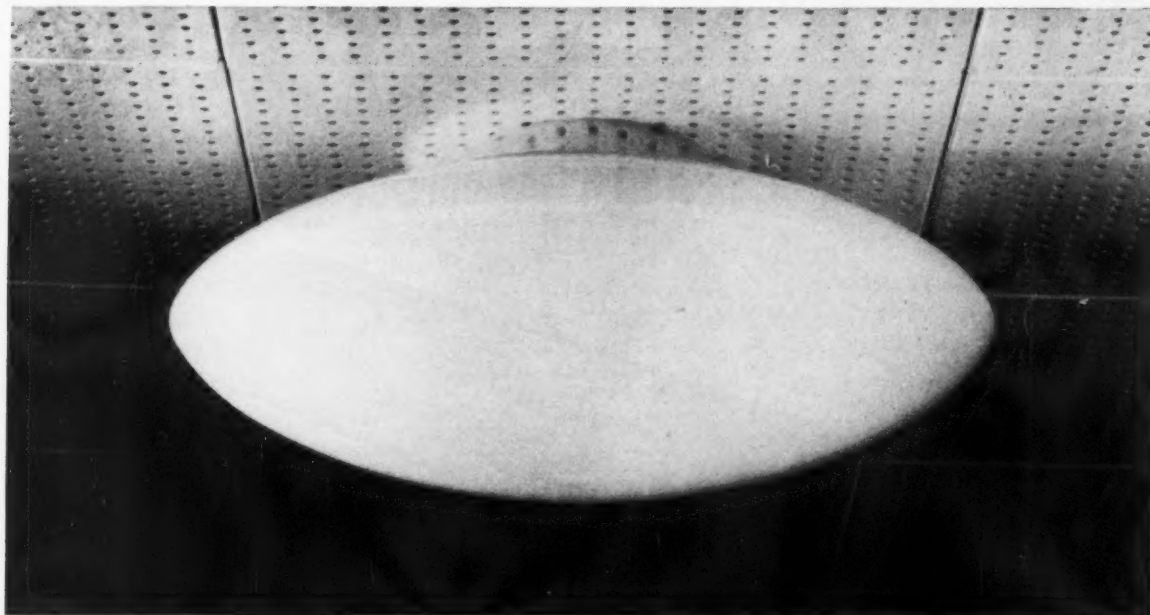
Outstanding features include :—

- Side entry mounting, the bracket being concealed within the lantern body.
- Modern body design incorporating concealed hinges and catches supporting the "Perspex" enclosure.
- Optical control obtained by "Perspex" refractor plates bonded one to each inner side of a tapered "Perspex" bowl.
- Tube operating gear housed within the lantern body.
- Hinged top to the body enabling the tube operating gear to be examined the right way up.

This lantern has been specially designed for main road lighting and combines the new inclined tapered appearance with a highly efficient optical system.

The lantern houses three 5 ft. 80W.

Osram guaranteed fluorescent tubes.



MA 1500 series from 34/8 plus tax

Designed by Paul Boissevain, Dip. Arch. M.S.A.

announcing the new **ELLIPSE SERIES** 10" 12" 14" 18" & 22" 60-300w

The Ellipse series provides architects and engineers with a basic range of 120 elegant lighting fittings, of slim appearance, which do a first class lighting job. The quality and finish is of the highest order, and the construction without use of screws or levers is simple, effective and foolproof, allowing for easy fixing and maintenance.

Prices are comparable with standard commercial units. Full details, including dimensioned drawings, are given in publication MA 1500 available on request.



THE MERCHANT ADVENTURERS LIMITED

16-43 PORTLAND ROAD LONDON W.11

TELEPHONE PARK 1221 (5 lines)

TRAN ★ STAR

LIGHTING CONTROL UNITS

REGD. TRADE MARK

PIONEER OF ALL
SELF-CONTAINED
INSTANT-START
BALLASTS



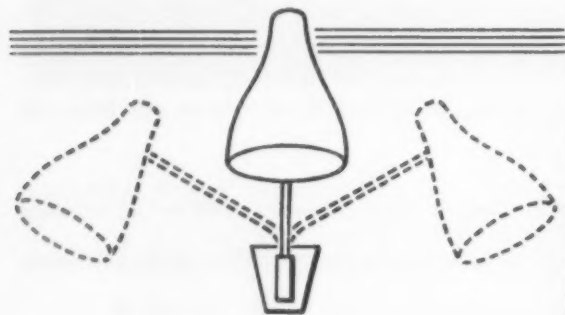
DESIGNED
TO ENSURE
FULL LAMP LIFE
HIGH LUMEN OUTPUT
SILENT OPERATION

FITTED WITH HIGH-TEMPERATURE RESISTING CAPACITORS
AND
GUARANTEED FOR 3 YEARS

Sole Manufacturers
INDUCTIVE APPLIANCES LTD. ST. NICHOLAS ST., NEWCASTLE UPON TYNE 1

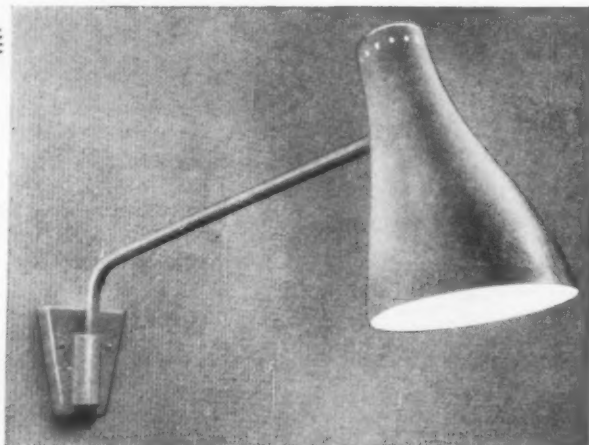
Tel. Newcastle 27069

Works Tel. Hebburn 32221



Designed Particularly for Hospital Bed Lighting

the projecting arm can be varied in length, all are fitted with "rigid" or "swivel" movement wall fixing plate. The shade is fixed by a non-rotating universal joint to the projecting arm. Made entirely from aluminium, it is light in weight yet robust. Finished to suit particular requirements and wired with B.C. lamp-holders ready for installation.



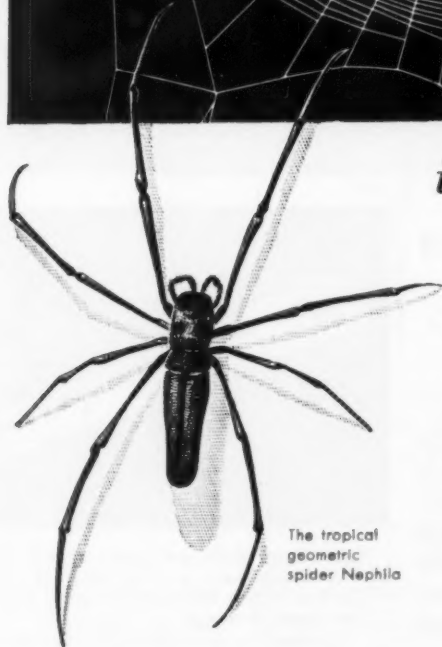
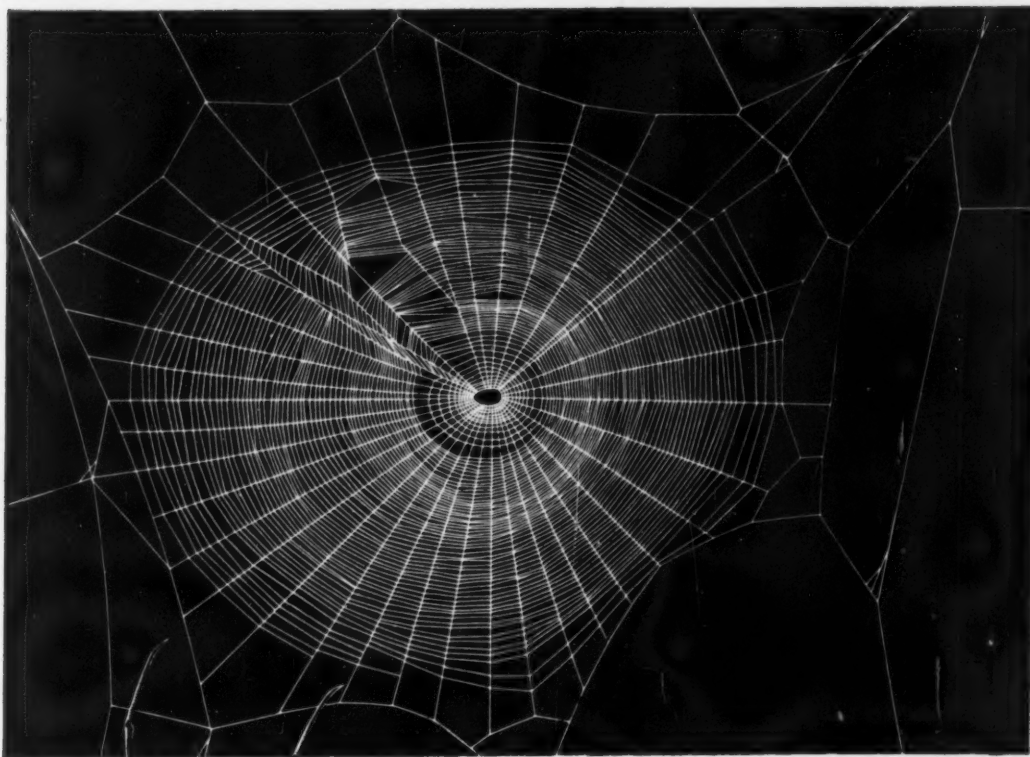
★ *Our New Comprehensive Lighting Catalogue is now available and will be sent on request.*

S.L.R. ELECTRIC LTD.

WELBECK WORKS, WELBECK ROAD, SOUTH HARROW, MIDDX.

Phone: BYRON 3273-5

Grams: ESELAR, HARROW



The tropical
geometric
spider *Nephila*

it hangs by a thread . . .

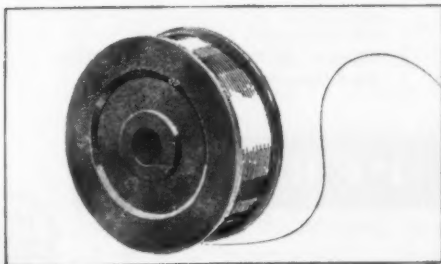
The wonders of Nature are often captivating in both senses of the word. The spider spinning its thin but tough web produces a thread that can hardly be measured. It is roughly 0.275 mils thick!

But the wonders of Nature are surpassed by modern engineering . . . At the Luma Works, the largest Scandinavian producers of incandescent and fluorescent lamps, tungsten and molybdenum wire is produced which, like the spider's thread, is not measurable by normal methods. The finest tungsten wire is only 0.197 mils thick.

Luma exports 90 per cent of its tungsten and molybdenum wire, and Luma wire is used in radio valves and bulbs in more than 50 countries.

You, too, can get Luma wire in all dimensions and finishes — e. g. black, cleaned or plated, semi-finished rods or finished electrodes.

Write immediately for our new tungsten catalogue in English, French or German.

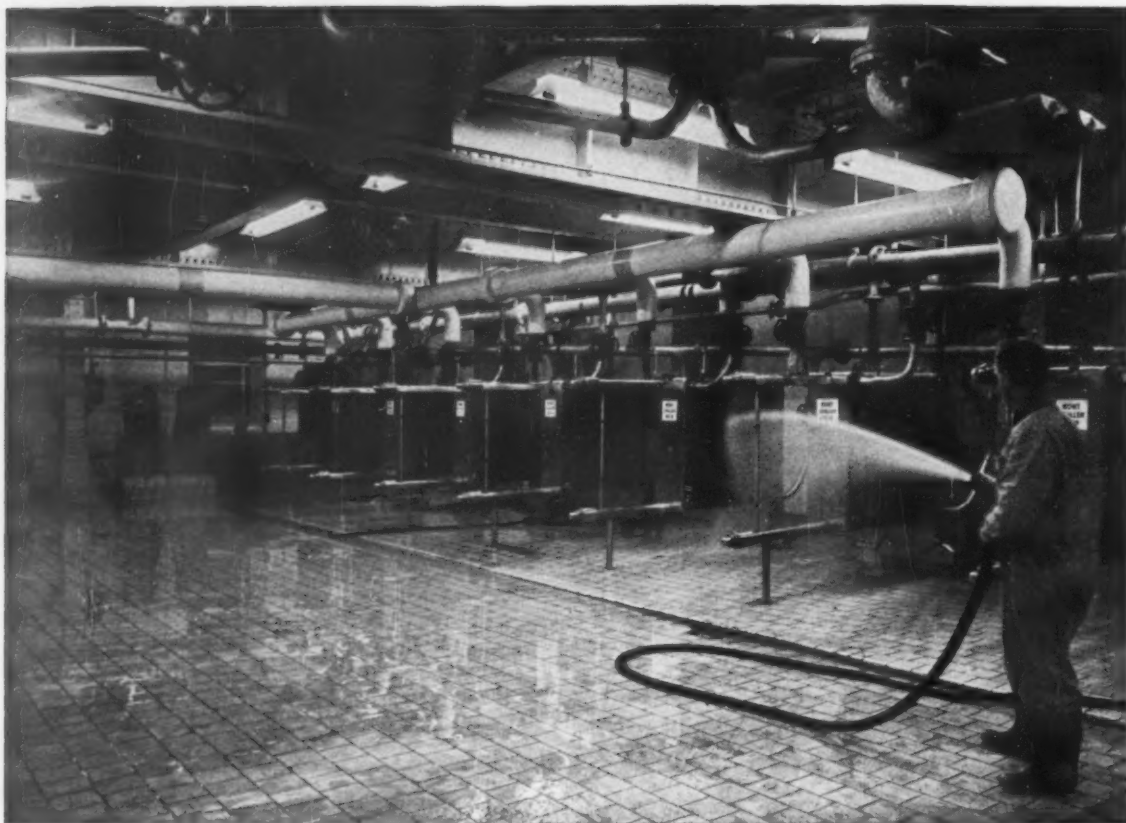


We manufacture all types of incandescent, mercury vapour, neon and fluorescent lamps, fluorescent fittings and accessories.

LUMALAMPAN AB

STOCKHOLM 20, SWEDEN
Cables: LUMALAMPAN STOCKHOLM

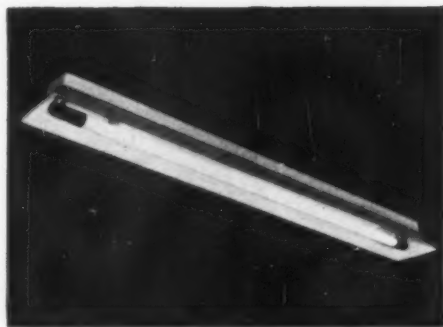




'Perspex' anti-corrosion lighting fittings at Guinness Brewery

OPAL 'PERSPEX' was chosen for this installation of A.E.I. Lamp and Lighting Co. Ltd. 'Watershed' fittings at the Park Royal Brewery of Messrs. Guinness because these fittings must resist the corrosive effects of condensation. In addition, the material chosen had to be one easily cleaned of mould growths which are particularly prevalent in fermenting houses. 'Perspex' is a tough, light material that will last for many years without deteriorating. Designers enjoy working with it because it is easy to shape and offers considerable scope for imaginative design.

'Perspex' is available in clear and opal sheet and also in a wide range of attractive, modern colours.



Opal 'Perspex' reflector anti-corrosion 'Watershed' fittings made by A.E.I. Lamp and Lighting Co. Ltd., 370 of which are installed in Guinness' Park Royal Brewery.

Lighting in breweries must withstand wet atmospheres. Areas are hosed down frequently and steam is used extensively for sterilising pipes and equipment. One reason for the choice of 'Perspex' in these fittings is its ability to withstand these atmospheres.

'Perspex' is the registered trade mark for the acrylic sheet manufactured by I.C.I.

'PERSPEX'



IMPERIAL CHEMICAL INDUSTRIES LIMITED • LONDON • S.W.1
FP.65

Light and LIGHTING

Vol. 51. No. 9. September, 1958

Published by The Illuminating Engineering Publishing Co. Ltd.
on the 1st of each month at 32, Victoria Street, London, S.W.1.
Telephone: ABBey 7553. Subscription rate 30s. per annum.

contents

289	Editorial
290	Notes and News
292	Lighting at Brussels by Bryan Westwood
299	Artificial Light and Plant Growth by A. E. Canham
303	Colour Science and Lighting Practice by H. D. Einhorn
309	Uniformity in London's Street Lighting
312	The Villa d'Este, Rome
314	New Products
316	Postscript by "Lumeritas"

Street Lighting in London

THE extraordinary variations in the lighting of the principal thoroughfares in the London area have excited adverse comment in the daily Press and the motoring journals from time to time, and we have not been uncritical ourselves in this matter. The metropolitan borough engineers and surveyors have, of course, been aware of this criticism and their Association set up a sub-committee in 1955 to consider the practicality of remedying the present lack of uniformity. The report of this sub-committee has now been published and is reviewed elsewhere in our pages. As its title indicates, the report consists mainly of practice notes for street lighting in London, and these make it clear that complete uniformity is impracticable, although some of the existing local differences can and should be removed. The question is how soon can a greater degree of standardisation be brought about? There are competing claims on local finances and implementation of improvement schemes which have already been drawn up is subject to delay which can vary in duration among the 29 authorities concerned in the lighting of London's streets. A central co-ordinating authority is recommended, but this could do nothing to expedite improvements.

Notes and News

SON ET LUMIERE seems to be catching on in this country. This summer (if one can call it a summer) sees three such shows in operation. Greenwich, which last year was sponsored by the *Daily Telegraph*, has been taken over by Atlas Lighting, who are putting on the performance on behalf of the Ministry of Works, and are, of course, providing the lighting. The *Daily Telegraph* is sponsoring a new show at Cardiff Castle, where Atlas are also doing the lighting. The third show is at Gloucester, where the cathedral forms a particularly fine setting.

We haven't yet seen either Cardiff or Gloucester, but we have seen the new show at Greenwich, which in our opinion is vastly superior to last year's effort. The script is better and Charles Laughton gives an impressive performance; his hoarse whispers are thought by most people to be most dramatic though we thought they were a little overdone. However, that is a minor detail and our main interest is in the lighting effects, which were very good. Bearing in mind the way that Atlas have been stressing their coloured fluorescent lighting we had expected to see much more saturated colours used; colour is in fact used very discreetly and we think Atlas have shown commendable restraint in their use of colour to produce very appropriate effects. The script has been revised and seemed to be almost entirely new, but we understand that some of last year's script is still used. The story is, however, much more coherent and we left Greenwich determined to return in the near future to explore as much of the Maritime Museum and Naval College as is permitted; this performance of *Son et Lumière* certainly brings Greenwich to life.

Of Gloucester we only know what we have been told and our informant might have been biased. He has, however, seen quite a number of these shows both here and in France and his opinion is that only at Gloucester and Versailles is the marrying of dramatic lighting with the history of the building really successful. The script was written by Charles Brewer (of BBC fame), who also produced the show. The scene is dominated by the cathedral, which towers above the audience, and as the site has so many historical associations it is no doubt easy for the audience to imagine the whole of the story being enacted in front of them. The lighting is carried out by Strand Electric.

At Cardiff the keep of the castle and its enclosing grounds provides what is probably an ideal setting. The lighting system is similar to that at Greenwich.

with fluorescent lamps providing the colour and filament lamps the directional effects.

What is particularly interesting to us about these current performances is that after the French started this fashion so many people in this country said it would never work here. We, you may remember, argued that it would. Even after the shows at Greenwich and Woburn last year there were many who said that the idea wouldn't spread. True, three shows this year instead of the two last year isn't much of a spread, but the three shows by all account are so very much better than last year's initial efforts. Both producers and lighting people have learned a lot and we still think we may see a good many more performances of *Son et Lumière* in this country before very long.

CIE—Brussels

The 14th session of the International Commission on Illumination (CIE) is to be held in Brussels from June 15-24 next year. Quite a lot of people in Brussels are already (in spite of the claims of the Expo on their time) getting busy preparing for it; and a lot more people in other countries should be equally busy doing their stints in preparing the reports of working parties and secretariat committees. Let's hope the latter are well in hand; it would be such a nice change to have *all* the pre-prints before leaving for Brussels.

We have seen a provisional programme from which it looks as if we shall be kept fairly busy during the nine working days, Sunday being a day off when no doubt the Belgians will arrange something for our entertainment. The morning of Monday June 15th will be taken up by the opening plenary meeting after which the remainder of the week will be devoted to receiving and discussing technical reports. The first two days of the second week are allocated for the presentation of individual papers and the conference closes on the Wednesday morning with the final plenary meeting at which the recommendations of the various technical committees will be considered.

The President of the CIE for the current session is, of course, Dr. J. W. T. Walsh, O.B.E., and no doubt there will be a fairly large party of experts from this country at Brussels to support him and also to see that developments in this country in lighting equipment and techniques are given a good hearing. People also attend these meetings to learn what is being done in other countries and one of the features of the CIE is the very free exchange of information which takes place.



One of the director's offices in the new London offices of IBM United Kingdom Ltd.



Left, an unusual view of the Atomium. At night small lamps set flush with the surface of the spheres are switched on and off to give a sparkling effect. The little aerial cars are each lit by a single lamp. Opposite, at foot of page, the water ladder, ingeniously constructed in the form of bays separated by troughs. Although the general movement is, of course, downhill, the water wells up in each bay and appears to flow in the opposite direction. Smooth water contrasts with water breaking in the troughs, while concealed lamps light the bays in contrasting pairs of colours.

Bryan Westwood, F.R.I.B.A.,
gives an architect's
personal impressions of

Lighting at Brussels

MY principal impression of the lighting at the Brussels Exhibition is the completely unobtrusive way in which it plays an integral part in the design of the site as a whole. No one has attempted to turn night into day; instead, the darkness is exploited and, from dusk onwards, the exhibition takes on a fairy-like quality, with its presiding genie—the Atomium—becoming much larger than life.

Experts may say that there is little to be learnt from the lighting of the exhibition, but it is surely worthy of study on account of the subtle and pleasing effects that have been achieved. It is, in fact, the *end* rather than the *means* that justifies our interest in it. As readers of *Light and Lighting* will already be aware, the general principle on which the site lighting is based is that the light should come from the buildings themselves. In the design of the new buildings this has been easy to arrange, but with the permanent buildings in the Belgian section remaining from the 1935 Exhibition the scheme is less successful. These buildings have been given a "face lift" and lighting has been "applied" to them, but the result is inartistic and has a "commercial" atmosphere.

In the foreign section I saw no system of outdoor lighting from standards, except where standards used for other purposes also carry lighting fittings. Indeed, in this area there are no large areas brilliantly lit. Elsewhere, where the light from the buildings themselves is insufficient to light the outdoor areas, there are well-designed plastic lanterns on simple metal standards.

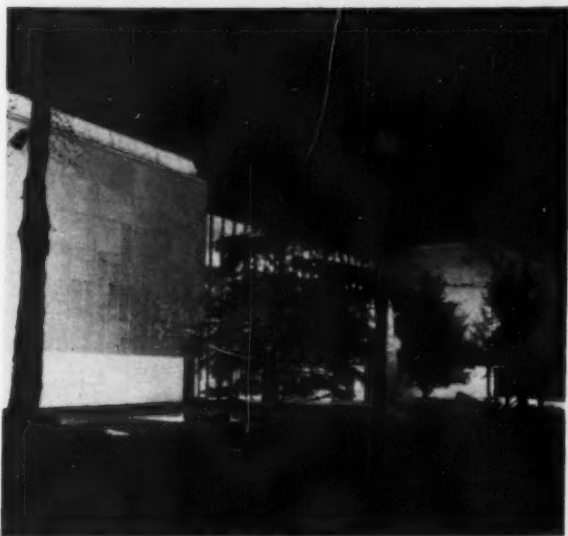
The most noteworthy effect at night is the way in which, in contrast to the daytime view, one's interest is continually focused on things specially designed to be

seen. As the visitor walks around the site his attention is drawn to the exhibits quite naturally, without the need for exceptionally high intensities of light. In this scheme of things one notices in particular a shaft of light on the bells at the top of the bell tower; a group of plants lit by lamps in an inverted trough; the lamps—like luminous currants—inside the clipped trees; pools of light on the lawns around several of the pavilions; edge-lit "Perspex" sculpture; and, above all, the illuminated cascades and fountains which, in this setting, are allowed to play a major role.

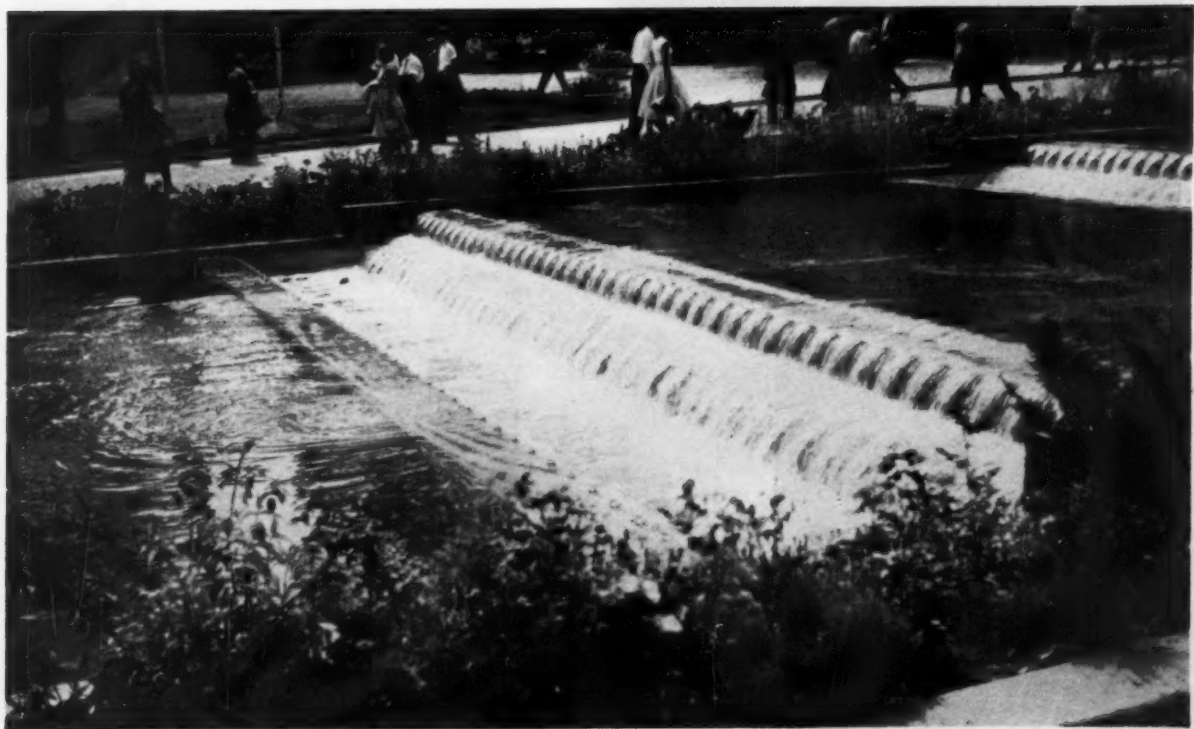
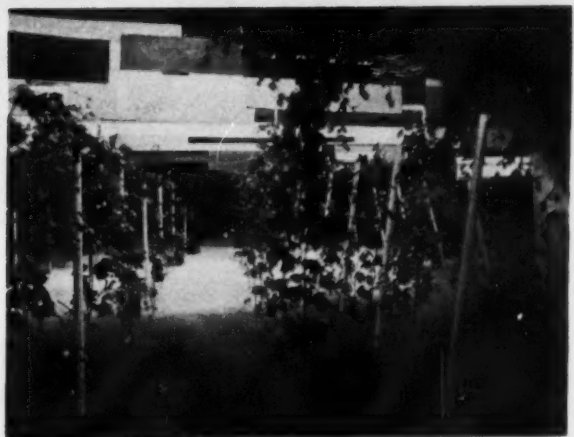
Coloured tubing is used effectively in many of the pavilions, in connection with various types of display, but I saw nothing even slightly reminiscent of Piccadilly Circus. Neon tubing is, however, ill-used in outlining the directional signs and is unconvincingly applied to the permanent buildings, but here and there it provides a welcome splash of colour. Various symbols are outlined with tubing and, inside the pavilions, particularly among the displays of electronic equipment, violently flashing exhibits provide animation to the scene.

At night, the exhibition gardens are full of interest. There are masses of small lights; the ever-changing colours of the fountains and the water-ladder; the single lights in the overhead bucket cars moving amongst the foliage; and, above all, the galaxy of twinkling lamps on the spheres of the Atomium. These lamps are set flush with the surface of the aluminium spheres and flash on and off to create patterns symbolic of electronic movement within the structure of the atom.

Inside the pavilions, as a contrast to concentrations of light on the displays, there is much dimness. In the



Top right, lighting of fountains and plants in the Ossegem park area. Right, a vineyard display in the Czechoslovakian pavilion. An illusion of reality is created by the use of false perspective, accentuated by graduated lighting from concealed sources. The showcase is less than 8 ft. deep. Above, general view of Czech pavilion. Areas of glass cladding, through which light floods out on to the site, alternate with solid walling which is itself floodlit.





Above, general view of room in Italian pavilion showing use of highly ornamental lighting fittings, made of ceramic, with internally-silvered lamps used as spotlights. Left, also in the Italian pavilion are these louvered fittings in black and white stove-enamelled metal. Below, this 12-ft. chandelier is the main element of another large room in the Italian pavilion. It consists of small cast-glass lanterns strung together (see close-up, below left), while small lamps are set on vertical rods in the hollow centre of the assembly.

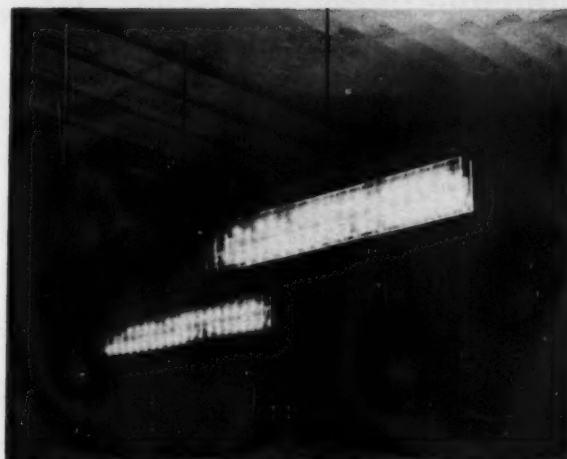
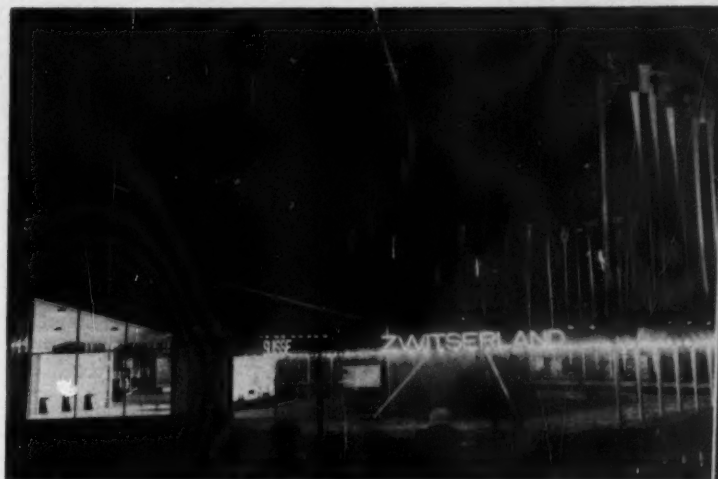


Right, general view of Swiss pavilion. Centre, close-up of lighting fittings in the restaurant of this pavilion. Somewhat mechanistic, but effective nevertheless, they consist of sheets of translucent plastic separated by an assembly of small lamps on a plastic egg-crate. Bottom, Hebrew characters about 4 ft. high outside the Israeli pavilion catch the light from internally-silvered lamps set in the lawn, forming an effective and decorative feature.

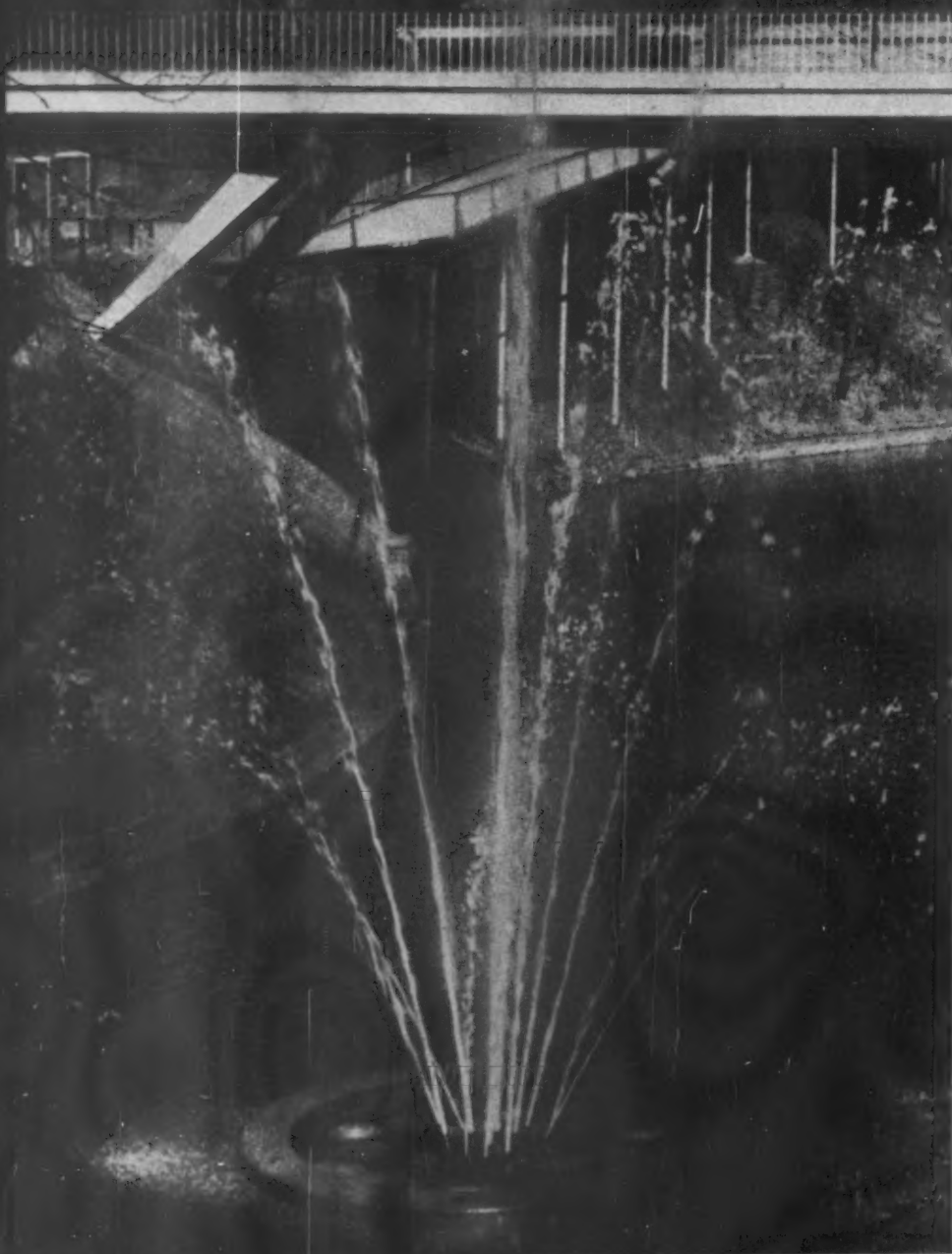
British pavilion, this is carried to an extreme. The darkness gives great decorative force to the richly coloured symbols of State and authority and forms a dramatic prelude to the other parts of the pavilion which are full of light. In the Italian pavilion most of the rooms are windowless or nearly so, and the museum-like atmosphere is heightened by the extraordinary lighting fittings seen in the photographs. These, as is general in most of the pavilions, are hung not far above the exhibits they are intended to light. Clearly, the designers had no inhibitions about long lengths of flex!

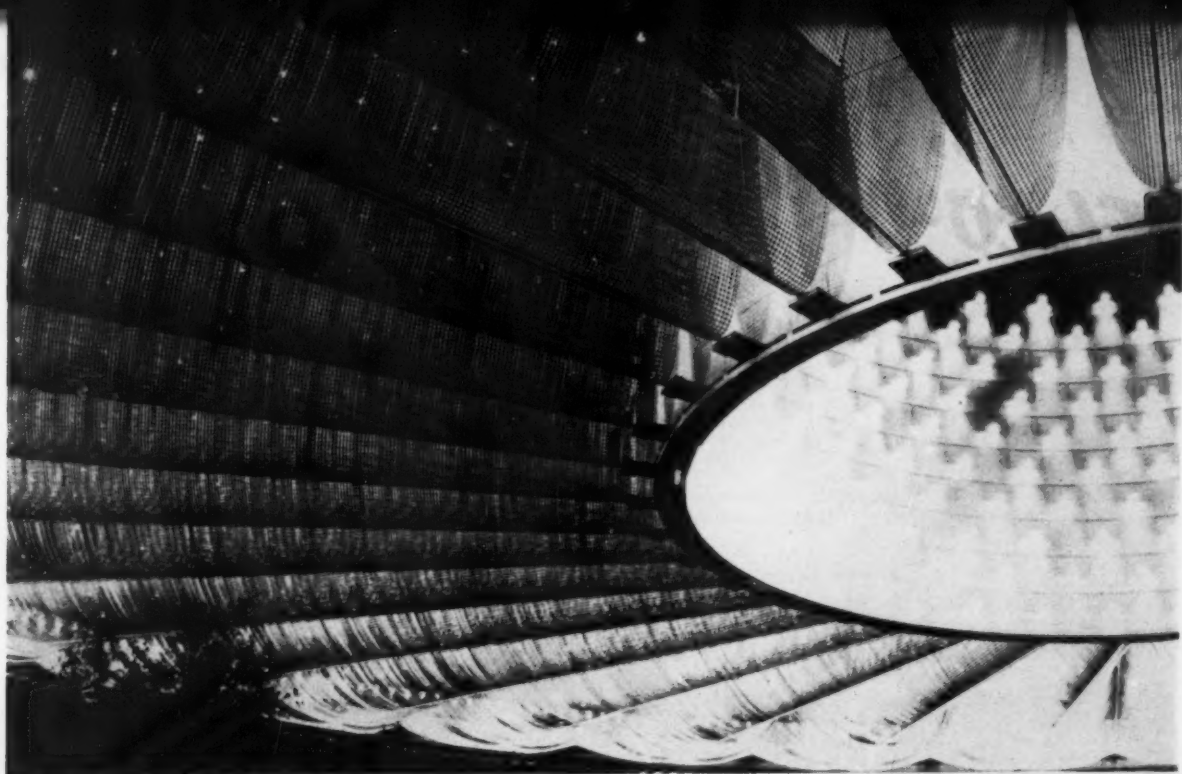
The Russian pavilion is one of the few where high-intensity general lighting is used throughout. The United States pavilion has general lighting most beautifully handled, but it gives a soft illumination. The hollow drum in the centre of this great circular building has affixed to it downward-shining lamps on a gold background, while the rest of the ceiling, draped with a wire mesh, is lit by myriads of points of light. These are excitingly reflected in the great pool which occupies the whole of the central part of the pavilion. During the day the exhibits seem rather a jumble, but at night, when colours are toned down, the visitor entering this pavilion truly gets the impression that he is entering a new world.

In the solutions to the detailed problem of internal lighting, the restraint exercised outside is again apparent. The half-silvered bulb is everywhere in evidence, but larger, utility fittings are hidden away. Where fittings are seen they are nearly all of special design and many of



Left, footbridge over the Osseghem park area. The fountain in the foreground is lit by a ring of under-water projectors set around the base. Below, small tambourine-shaped lighting fitting used to give pools of light on the lawns around the West German pavilion. Bottom, tubular fitting in opal plastic used for lighting plants and borders in the garden areas.



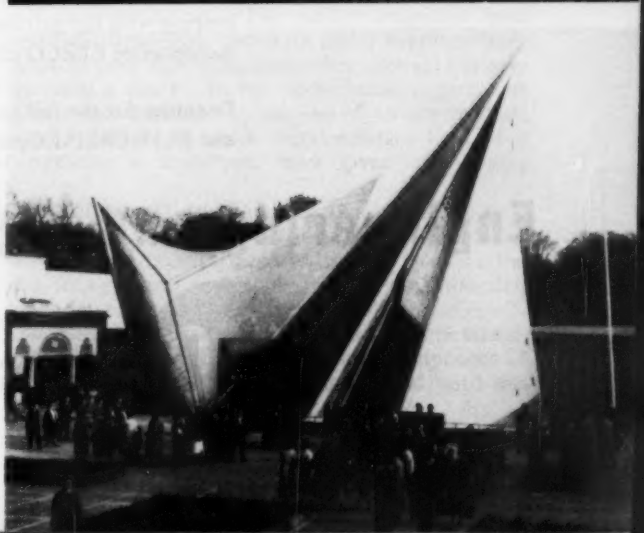


Above, the roof of the United States pavilion. The huge circular opening is lined with downward-facing lighting fittings which illuminate the gold background, while a large number of small lamps are placed above the draped mesh of the ceiling. (Photo by courtesy of John Edgington and Co. Ltd., contractors for this 350-ft. dia. ceiling.) Right, Turkish pavilion. Glass cladding is fitted with venetian blinds adjusted to direct light outwards and to add visual interest to the façade. Bottom, Philips' pavilion, designed by Le Corbusier. Consisting of a series of unequal hyperbolic paraboloids, it serves as an auditorium for Corbusier's "electronic poem"—an extraordinary eight-minute performance of light, sound and colour.

them are well worthy of note. A massive chandelier in an almost empty room in the Italian pavilion is truly a *tour de force*. It consists basically of hundreds of cast-glass hexagonal units with vertical rows of small bulbs in the centre. At the other extreme there is Le Corbusier's "Electronic Poem" in the Philips' pavilion, where light of many colours "moves" around the interior of a building rather aptly described as a "collapsed tent." This performance is accompanied by projected pictures and by extraordinary noises.

In conclusion, I would like to emphasise the feeling of restraint which I mentioned above. To me, as an architect aware of progress in lighting, but not a lighting expert, it seems that various developments in lighting—cold-cathode tubing, fluorescent and discharge lamps, powerful floodlights, etc.—are no longer novelties. They are, today, the normal tools of the lighting engineer. The man with sufficient imagination to use them effectively has no need to show off by using higher and higher intensities. Thus, I think that the Brussels Exhibition will be remembered as an important occasion on which well-understood lighting methods were used in a thoroughly adult way.

Except where stated otherwise, photographs are by the author or by Sado (of Brussels), or were taken specially for *Light and Lighting*.



"Eleco"-way the right way to Streetlighting



Pelham Bridge Lincoln. Officially opened by H.M. The Queen and H.R.H. The Duke of Edinburgh in June, 1959.
(Photograph by the courtesy of A. Adlington, Esq., A.M.I.C.E., M.I.Mun.E.).

The above photograph shows an ideal street lighting installation, using ELECO SILVER RAY LANTERNS for Colour Corrected Mercury Lamps on steel columns. This combination is completely appropriate and in keeping with the surrounding architecture and provides a fine installation, which incorporates ELECO efficiency and high quality and is also most attractive.

Enquiries for the full range of ELECO Street Lighting Lanterns and equipment and ELECOSLIM Concrete Columns should be sent to:—

Engineering and Lighting Equipment Co Ltd



Sphere Works, St. Albans, Herts. Telephone: St. Albans 54524/5, 6

Artificial Light and Plant Growth

By A. E. CANHAM*

M.Sc.(Eng.), A.M.I.E.E.

During the last few years much progress has been made in the irradiation of plants by artificial light and the number of commercial installations has increased. This article reviews developments in this country and overseas.

It is now five years since this subject was last discussed in these columns, and during this time a number of developments have taken place both in this country and on the Continent. A little more is now known about some of the ways in which a few of the more important plants react to light, though there is still a long way to go. Light sources have not changed appreciably, and the horticulturist is still as far as ever from a source which could be regarded as ideal.

However, considerable use is now being made of artificial light, both in horticultural research of all kinds and in commercial horticulture, to modify natural light conditions, which are seldom adequate and always variable.

The economic advantages of early tomatoes and cucumbers have led many growers to instal light irradiation equipment, although in some instances other factors have reduced the benefits which might have been obtained. Similar equipment is now in widespread use at research stations, enabling a wide variety of plant material to be grown all the year round. This is necessary for a wide range of purposes, varying from plant breeding to maintaining stocks of greenfly for virus research.

The importance of constant environmental conditions in many aspects of research in horticulture and plant physiology has led to a considerable demand for growth rooms and cabinets in which all the light is provided artificially. The advantages of such closely controlled environments in commercial horticulture will be considerable if the economic and practical difficulties can be overcome. Work at present in hand both in this country and in the Netherlands suggests that a simple growth room may well become an important addition to the range of equipment of the up-to-date grower. Nevertheless, the vision of the future glasshouse as a "... seven-storey windowless building with all the light provided artificially ..." prophesied recently by an eminent horticulturist, is still a long way from reality.

The control of the flowering and breeding habits of many plants by the artificial control of the day-length is now well established in horticultural practice for a limited number of plant species, but the practical possi-

bilities are likely to become very much wider as the results of more research become available.

Supplementary Lighting

In spite of the disadvantages in terms of the cost and bulk of the control gear, the 400-watt type MA/V lamp still remains the standard source for supplementary irradiation in this country, although on the Continent it is apparently being superseded by a lamp of the MBF/U type. Fittings have been improved, and there are now two types on the market designed especially for horticultural use. The earlier GEC trough fitting taking an MA/H lamp has been superseded by a new reflector of super-purity aluminium which is open at each end, and incorporates a magnetic deflector, enabling the more efficient type MA/V lamp to be used.

Benjamin Electric Ltd. have produced a stove-enamelled fitting, for an MA/V lamp, which is said to reduce the amount of radiant heat falling on the plants.

Both fittings have been installed commercially in comparatively large numbers, but while the benefits for an early cucumber crop are unquestioned, for tomatoes considerable skill is required to ensure the best results. In addition, good control of the glasshouse air temperature is essential in the propagating stage, and in many cases lack of success with tomatoes has been due to the shortcomings of the heating system. High night temperatures result in smaller flower trusses and in more leaves appearing before the flower truss, and if this is excessive, fruiting may be delayed instead of accelerated even though the response of the plants in terms of size may appear at first sight to be excellent. Again, irradiated plants must be grown on without a check; subsequent poor natural light conditions may reduce the advantage and planting into cold soil will certainly do so. The sudden transition from the good light conditions obtaining under supplementary irradiation to poor light conditions when planted out may itself produce a check. In the Netherlands, experiments to facilitate this transition by the use of an intermediate "weaning" period, in which supplementary light of a lower intensity is employed, have given encouraging results.

The use of the 500-watt mercury-tungsten lamp, type MAT/V, has been recommended in some instances as an alternative to the normal mercury lamp. Used in the elliptical fitting mentioned above, it has the attraction of a much lower first cost. However, under some conditions, undesirable formative effects have been obtained, due to the presence of the near-infra-red component of the radiation from the tungsten filament, and until this

*The author is with The Electrical Research Association.



Fig. 1. Latest type GEC plant irradiators in use on a wide range of plants for research purposes.



Fig. 2. Benjamin horticultural fittings in a tomato nursery in Guernsey.



Fig. 3. The use of mercury lamps enables gerberas to be grown in Denmark.

reaction has been more fully explored this lamp should be used with caution.

In the Netherlands the HO 2000 450-watt mercury vapour lamp has been superseded by a 400-watt mercury fluorescent lamp for horticultural purposes, while the possibilities of the internal-reflector fluorescent tube are being explored. In Russia it is claimed that a combination of incandescent lamps and fluorescent tubes have given better results than fluorescent tubes alone. Supplementary lighting is also widely used in Scandinavia, with a preference for fluorescent tubes; in Norway it has been successful with stocks and antirrhinums, while in Denmark its use has been found essential for growing gerberas.

In America this technique has been "domesticated" to a considerable degree, and by combining suitable lighting equipment with ornamental stands and supports for house plants not only do the plants flourish—which they seldom do under normal house conditions—but the result is extremely decorative. The idea has been adopted to a limited extent in this country, but it is a development for which there is considerable scope for lighting ingenuity and artistic skill—and also a large potential market.

The need for a controlled environment in a wide range of research problems involving the growth of plants has led to a considerable demand for artificial light sources. The problem is not too serious where a moderate lighting level is adequate, but uniform intensities of anything very much greater than 25 per cent. of noon summer sunlight over a reasonable working area are very difficult to achieve satisfactorily.

A prerequisite of a light source suitable for growth rooms is a balanced spectral distribution, as the plants will not get the benefit of any daylight which might help to make up for deficiencies in the quality of the artificial light. Red light is essential for the maximum rate of growth; on the other hand, a proportion of blue is necessary to produce a plant of "normal" shape; infra-red radiation has undesirable "drawing" (stem elongating) and heating effects, so the lamp emission should contain as little of this as possible. Fluorescent tubes are ideal in many ways, but their low output necessitates the use of a large number mounted close together, and often some form of local tube cooling must be provided to maintain their efficiency. The internal-reflector tube is a useful development in this field, but the satisfactory development of high-output tubes would be an important contribution to the research facilities of the horticultural industry and also to commercial horticulture in general.

The choice of tube colour is naturally important in order to obtain a satisfactory ratio of blue light to red; the most satisfactory types are daylight and warm white, but some plants even respond differently to each of these, and as there is such a wide range of plants involved this is one aspect which requires much more research. There is also some evidence, largely from America, that better results are obtained with fluorescent tubes if a small proportion of incandescent light is included.

A combination of mercury and incandescent lamps, with an intermediate water filter, has been used in at least one installation in the Netherlands, but the merits of the more recent type MBF/U lamp have yet to be fully explored.

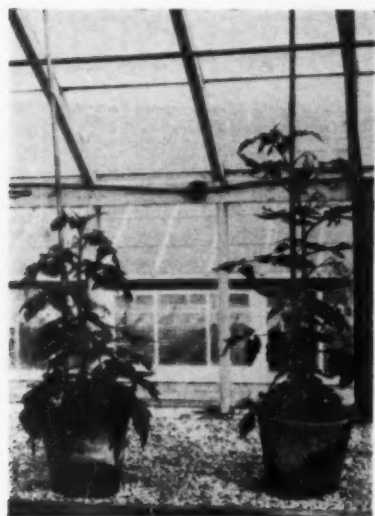


Fig. 4. Showing the effect of supplementary lighting on tomatoes. The plant on the right received 12 hours extra light daily for three weeks in the seedling stage. The plant on the left received only normal daylight.



Fig. 5 (centre). Decorative wall and table fittings for house plants.



Fig. 6 (right). Decorative lighting effects for house plants in the darker areas of a house.

The Commercial Growth Room

As the prime requirement of such a room for successful application in commercial horticulture is low capital and running cost, obviously a lower light intensity than that demanded in a research installation must be tolerable for the idea even to merit consideration. Its task would be to replace the glasshouse—a building which is designed to make the maximum use of daylight at the expense of heating efficiency—for certain purposes and at suitable times of the year.

A considerable saving of heat can be effected by the use of well-insulated walls and by growing the plants in tiers rather than on a single bench, and provided the additional cost of providing artificial light and suitable cooling arrangements is not too high such a system would have a place in commercial horticulture. The biggest advantage would clearly be in winter, when natural light is at its poorest and heating costs are greatest, and provided the intensity is no lower than that of natural winter daylight the possibility of maintaining this level uniformly for periods long in excess of the natural day-length should result in faster plant growth.

The possibilities of such a unit for growing tomato and other plants are being explored both by the ERA at Shinfield and also by the Dutch. The latter recommend an installed capacity of 240 watts per square metre (about 23 watts/sq. ft.) of 65-watt fluorescent tubes with internal reflectors, and claim that no separate space-heating system is necessary.

Plants which will grow satisfactorily in low light intensities obviously lend themselves more readily to this system of growing; saintpaulias, for instance—the popular African Violet—can be grown quite satisfactorily under single fluorescent tubes.

Bulb flowers, such as hyacinths, daffodils and tulips, need very little light in the course of their growth, as the flower is fully formed within the bulb at the time

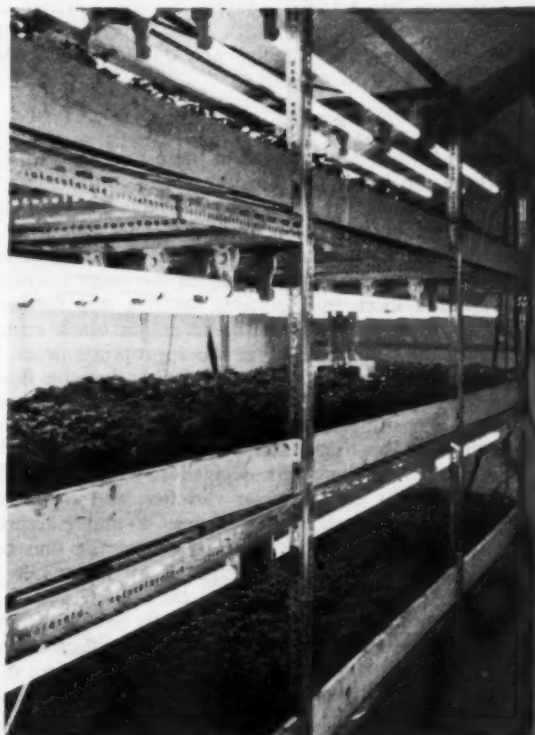


Fig. 7. Experimental growth room at the Institute of Horticultural Engineering, Wageningen, Netherlands, for raising tomato seedlings. Five 65-watt fluorescent lamps are used over an area of 1.5 sq. metres, 35 cm. above the plants.



Fig. 8. Tulips being forced under artificial light.

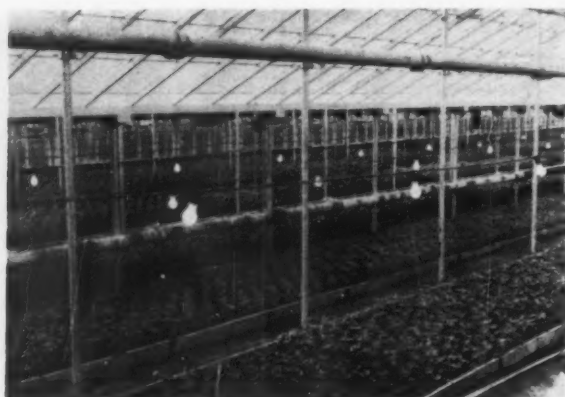


Fig. 9 (right). Part of a 280 kw. installation of 100-watt tungsten lamps for producing chrysanthemums all the year round.

of planting and it has enough food stored to ensure the complete development of the flower without the need for further photosynthesis. A little light is required only to give colour and strength to the leaves, stem, and flower, and this can easily be provided by 100-watt incandescent lamps installed at the rate of 100 watts/square yard of bench area.

Many growers have seen the advantages to be gained by using this system of forcing in cold stores temporarily out of use and in suitable sheds, compared with the normal method of forcing in glasshouses. One grower in Guernsey has actually adapted an old wartime concrete fortification bunker, with walls several feet thick, in which he has forced tulips and daffodils successfully during the last two seasons.

Extended Lighting

An important development in the use of artificial light to extend the length of the daily light period ("photo-period") to control the flowering of plants has been introduced quite recently from America. This technique has been used for some time to delay the flowering of mid-season and late chrysanthemums for the more favourable Christmas market, but this was taken a step further in America, and, combined with the use of black curtains to reduce the length of day at the appropriate times, has made possible the production of chrysanthemum flowers all the year round. The response of a large number of varieties was studied and the technique perfected so that flowering can be timed almost to the required day!

A few English growers decided to take this up and imported stocks of American varieties, and on at least two nurseries it has developed into a major industry, providing flowers all the year round on the one hand and vast quantities of rooted cuttings for home sale and export on the other.

The lighting installation could hardly be more simple: 100-watt incandescent lamps, without reflectors, suspended 6 ft. apart and 4 ft. high on catenary wires down the centre of each bed of plants. They are switched on for two hours in the middle of the night to provide a "light-break"—which is equivalent from the point of view of plant response to lengthening the day—for the period of time appropriate to the variety, the time of year and the required date of flowering. One of these nur-

series has no less than 280 kw. of lighting for this purpose and it is all used during "off-peak" periods.

The flowering of many plants can be controlled in this way, but few of them are at present of appreciable importance in commercial horticulture in this country. The results of recent research with trees and shrubs does, however, suggest that the appropriate control of day-length during the propagating period may be of great importance both in nurseries and in plant breeding. For instance, it has been shown in the Netherlands that the time to flowering of rhododendron seedlings can be cut by 50 per cent.—equivalent to a saving of about three years.

In Conclusion

This is a fascinating but complex subject. Light is but one of many environmental factors to which plants respond. The interactions of these factors on the infinite variety of plant species provides a problem of considerable proportions, but although progress is necessarily slow, it is certainly sure. To the lighting industry this application may appear too small to warrant serious consideration; to the horticultural industry it is of considerable importance. In no other field is it more true to say that "Light is Life." Every new lamp development may have important horticultural possibilities; who knows what the next quinquennium holds in store?

Acknowledgements

Acknowledgement is made to the following for the use of illustrations: Agricultural Supplies (Cambridge), Ltd., Fig. 1; Reading University, Fig. 3; Electrical Research Association, Fig. 4; Kollar Archives Apel, Figs. 5 and 6; Instituut voor Tuinbouwtechniek, Wageningen, Fig. 7; South Western Elec. Board, Fig. 8; *Smallholder*, Fig. 9.

A short course in illuminating engineering is to be held at the College of Further Education at Slough beginning next January. The course is intended for electrical contractors, industrial executives, display executives and building contractors. The lectures will be held in the evening. Subjects to be dealt with include light sources, fittings, circuits and auxiliary gear, home lighting, display lighting, etc. Further details may be obtained from Mr. L. F. Needham, College of Further Education, William Street, Slough.

Colour Science and Lighting Practice

Some of the fundamentals of colour science applicable to lighting practice are surveyed. The important difference between colour rendering and colour appearance of lamps, the CIE system and methods of specifying lamp colours are discussed.

(1) Introduction

The practical solution of colour problems is usually arrived at empirically, by artistic intuition bred by previous experience. The question arises whether a scientific approach would be worth while, consisting in an analysis of the physical and psychological experimental facts, and applying the conclusions to practical problems. A fair answer would be: *science should supplement art, not displace it.*

To ignore taste and experience might lead to unfortunate results; but to combine art with fundamental knowledge would be fruitful and avoid fallacies. And fallacies are quite common in the absence of thorough scientific understanding.

The aim of this article is to survey some of the knowledge gained on the physics and psychology of colour vision, and to consider its application to lighting practice.

(2) Physics and the Eye

Out of the wide range of electro-magnetic waves, heat radiation, X-rays, gamma rays, etc. (Fig. 1), a narrow band is directly perceptible to the human eye and we call it "Light." Light covers about one octave, between 380 and 760 $m\mu$; for most practical purposes 400 to 700 $m\mu$ only matters. (Note: $1 m\mu = 1/1,000 \mu$; $1 \mu = 1/1,000 mm$; hence $1 m\mu = 10^{-9} m$; $1 m\mu = 10$ Angstrom Units). Light's neighbours are UV (ultra-violet) and IR (infra-red). UV causes fading, freckles and fluorescence; IR is essentially heat radiation.

The human eye is complex, and there are peculiar gaps in our knowledge of it. The microscope shows "cones" in the retina, which do most of the work during the day (photopic vision), and "rods," which are mainly on night shift (scotopic vision). It is generally held that colour vision is mainly limited to the cones, but we are not quite sure of it. The three-receptor-hypothesis of Young and Helmholtz helps understanding, but is by no means physiologically established.

What we do know are certain empirical facts based on mass observations such as: the cones are most sensitive at about 555 $m\mu$, the rods at about 510 $m\mu$ (Fig. 1).

The author is Senior Lecturer in Electrical Engineering at the University of Cape Town. This article was presented as a paper to the Transvaal Centre of the IES in February, 1958.

By H. D. EINHORN, Dr. Ing., Ph.D.

Colours can be matched by three other colours in a predictable additive mixture.

(3) Facts About Colour Vision

Ever since Newton, we know that different wavelengths correspond to different colours, the "spectral colours."

The following facts, however, though emphasised by Ostwald, Judd and others, are perhaps not always fully appreciated:—

- (i) Monochromatic spectral colours are rare in practice.
- (ii) All practical light sources (except the sodium lamp) emit a mixture of wavelengths, expressed by their spectral energy distribution, E_λ .
- (iii) All highly coloured surfaces reflect over a wide range of wavelengths, expressed by their spectral reflection curve (ρ_λ). (See Fig. 1.) The eye is therefore usually presented with a conglomerate of wavelengths.
- (iv) The eye perceives this complex spectrum as one single colour; unlike the ear it does not analyse a spectrum, it integrates it.
- (v) Any colour (except certain spectral ones) may be caused by an infinite number of spectra.

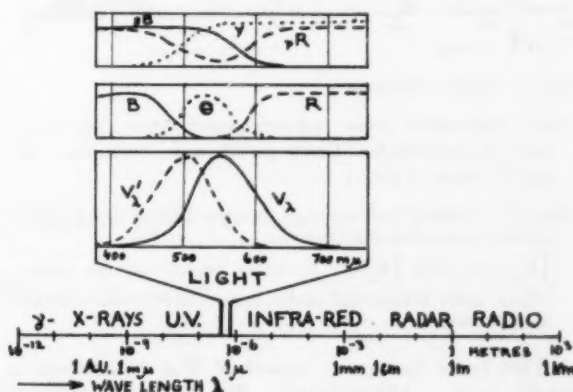


Fig. 1. Spectrum of electro-magnetic radiation and (enlarged) of light.

Energy (or spectral reflection factor) curves: Additive primaries: B = blue; G = green; R = red. Subtractive primaries: gB = greenish blue (cyan); y = yellow; pR = purplish red (magenta). Relative luminous efficiency curves: V_λ for photopic vision; V_λ' for scotopic vision.

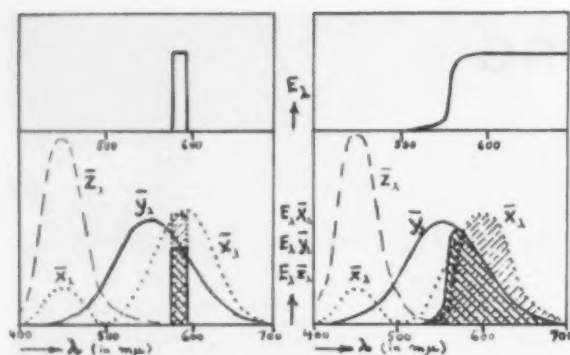


Fig. 2. Metameric Yellows.

Top: Energy curves (E_λ) of sodium light (left) and of a matching amber light with continuous spectrum (right).

Bottom: CIE-distribution coefficients \bar{x}_λ , \bar{y}_λ , \bar{z}_λ and their products with the energy curves above.

Sources look the same, because shaded areas under curves have the same ratio, i.e. $\int E_\lambda \bar{x}_\lambda d\lambda / \int E_\lambda \bar{y}_\lambda d\lambda$ is the same. (For the sake of simplicity colours were chosen with $\bar{z}_\lambda = 0$ throughout.)

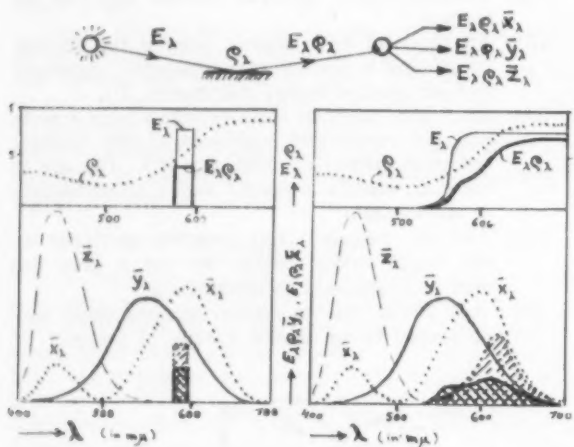


Fig. 3. Colour Rendering.

Top: Subtractive colour mixture occurs when light (E_λ) falls on object (ρ_λ). (Lights are the same yellows as in Fig. 2, object is pink.)

Bottom: Objects look different, because shaded areas under product curves have different ratios:

$\int E_\lambda \rho_\lambda \bar{x}_\lambda d\lambda / \int E_\lambda \rho_\lambda \bar{y}_\lambda d\lambda$ is greater on the right; object looks orange-red under amber light, yellow under sodium lamp.

This latter fact is so important that it warrants a special term: *Metamerism*. We call two colours metameric if they look the same but have different spectra. Metameric light sources have the same colour appearance, but different colour rendering.

An analysis of the relation between spectrum and colour vision will explain metamerism and its practical significance.

Table 1
Colour Mixtures

Type	Additive	Subtractive
Examples	Spectrum combination; three colour stage lighting; filters in parallel	Effects of light on object; filters in series
Suitable Matching Stimuli (Primaries)	(Spectral-) Red, Green, (Purplish-) Blue	(Purplish-) Red, Yellow, (Greenish-) Blue
Typical Mixtures	$G + R = Y$ $Y + B = Wh$	$gB + Y = G$ $G + pR = Bk$ (or Br)
Predictability	From appearance	From spectrum only

(4) Spectrum and Trichromatic Colour Vision

Normal human colour vision is called tri-chromatic because we can, as a rule, match any colour by three others, in an additive mixture. Certain special cases where two colours will suffice, or others where one of the matching colours becomes negative, do not invalidate this rule.

The Young-Helmholtz three-receptor-hypothesis forms a useful mental picture to understand colour vision. We can assume that the eye contains three receptor-mechanisms, with different response curves to spectral energy, and that colour is perceived as the ratio of the signals received by the three receptors. We can picture three photocells with different colour filters, whereby colour is determined by the ratios of the photo-currents. Photo-electric colorimeters have in fact been built on this principle.

The mathematical procedure is to multiply spectral energy E_λ by the "distribution coefficients" \bar{x}_λ , \bar{y}_λ , \bar{z}_λ , to obtain three weighted spectral curves. The colour quality of a light, called "Chromaticity" is then defined as the ratio of three *Tristimulus values* $X:Y:Z$, where $X = \int E_\lambda \bar{x}_\lambda d\lambda$; $Y = \int E_\lambda \bar{y}_\lambda d\lambda$; $Z = \int E_\lambda \bar{z}_\lambda d\lambda$.

Fig. 2 gives as example the curves for a sodium and a matching yellow filter spectrum. The light sources have the same colour appearance because the ratios of the areas shown are the same. But they are metameric because the spectral curves as such are totally different.

Tables of the distribution coefficients \bar{x}_λ , \bar{y}_λ , \bar{z}_λ , and of the relative luminous efficiencies V_λ and V_λ^{-1} , can be found in books and in the CIE vocabulary and that of the South African National Committee on Illumination.

(5) Colour Mixtures

At this stage a short digression into colour mixtures may be useful.

It is probably not always appreciated that different methods of mixing colours follow different colour mixture laws. (See Table 1.)

Additive colour mixture takes place when several lights are presented to the eye simultaneously on the same spot, e.g., the spectrum combination itself, or different lights falling on one diffusing surface. Similar in character are mixtures where colours are presented to the eye in

rapid succession as on a Maxwell disc or in close juxtaposition as in pointillist paintings (e.g., by Seurat).

Subtractive colour mixture takes place when two filters are placed one behind the other or when light falls on an object. Paint mixture is similar to subtractive mixture but not quite the same.

(6) Light and Object: Colour Rendering

Of special importance in illuminating engineering is the subtractive mixture of a light falling on an object.

Fig. 3 shows the mechanism. Light of spectral energy distribution E_λ falls on a surface of spectral reflection factor ρ_λ . The surface can only take light away, never add anything to the spectrum of the source (exception: fluorescent samples). The retina receives the modified radiation and divides it into three signals to the brain.

Mathematically one simply multiplies ordinates in a spectral diagram (Fig. 3), and the chromaticity of the object colours as seen under a particular light source is given by the ratio of the integrals $\int E_\lambda \rho_\lambda \bar{x}_\lambda d\lambda : \int E_\lambda \rho_\lambda \bar{y}_\lambda d\lambda : \int E_\lambda \rho_\lambda \bar{z}_\lambda d\lambda$. It is the intrusion of the factor ρ_λ which upsets the metameric match of light sources.

The conclusion is that the colour appearance of a light source can be quite misleading when assessing its colour rendering. One could, for instance, make a pink light source consisting of yellow and blue spectral lines, which then does not contain a trace of red spectral energy and hence is quite unable to render any reds in an object.

(7) Fluorescent Lamps

The metamerism of fluorescent lamps is more subtle than that of the sources just discussed, but is of utmost practical importance.

While the spectrum of incandescent sources is determined by Planck's radiation law and that of mercury and sodium discharge lamps determined by the atoms of the vapour used, the lamp-maker is able to alter the spectrum of fluorescent lamps very widely by choosing different types of powders. He can make a variety of near-white general purpose lamps apart from highly coloured ones.

There are two desiderata: (a) high efficiency, and (b) good colour rendering. These two aims are conflicting because it can be shown that for highest efficiency the emission in the yellow region (round about $580 \text{ m}\mu$) should be boosted, while for good colour rendering, especially of faces and food, ample red radiation well above $600 \text{ m}\mu$ is indispensable. But radiation in this region is of low efficiency, as can be easily seen for the $V_\lambda (= \bar{y}_\lambda)$ curve. (See Fig. 1 or 2.) The same applies to the blue region.

This dilemma has led to the development of two types of fluorescent lamps, those designed for high efficiency, the others for good colour rendering, which may either mean generally acceptable lamps such as the "warm white de luxe," or lamps suitable for colour matching. (See Table 2 and Fig. 4.)

As a rule one may expect efficiencies some 30 per cent, lower for lamps of good colour rendering, but this sacrifice in light or the extra cost of a greater number of lamps for the same amount of light is well worth while for applications where colour is important, e.g., in homes, hotels, exhibitions, or in shops where frocks, food or furniture are sold and in certain industries.

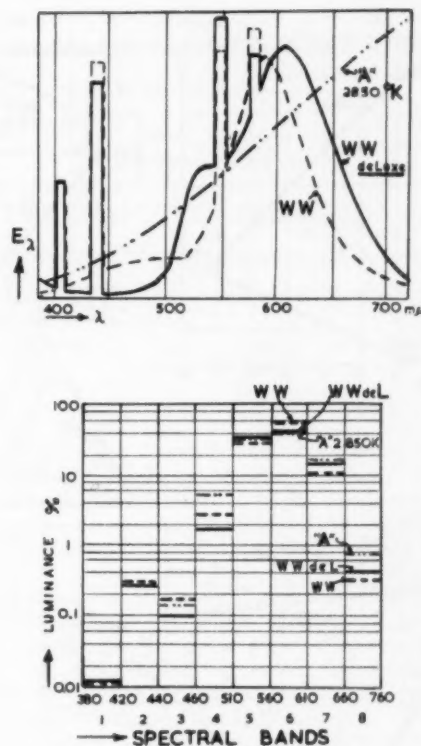


Fig. 4. Presentation of Lamp Spectra.

(a) Full Spectrum with mercury lines of fluorescent lamps shown as equivalent areas of $10 \text{ m}\mu$ width.

Ordinates: E_λ to linear scale; dimension: $\text{W cm}^{-2} \mu^{-1}$. Lamps look similar, i.e. are nearly metameric, but note red-deficiency of high efficiency ("standard") warm white lamp (WW), compared with "WW de Luxe" lamp or incandescent lamp "A".

(b) CIE-Eight-band presentation.

Ordinates: percentage-luminance to logarithmic scale. Same lamps as in (a).

Table 2
Classification of Fluorescent Lamps

Approx. Col. Temp., deg. K.	High Efficiency	lm/w	Good Colour Rendering	lm/w
2800-3500	Warm White, New Warm White, (Atlas-) White	47	Warm White de Luxe	30
4000-4500	British Daylight, Cool-White, (Philips)-White	45	Natural, (Cool-) White de Luxe	35
± 6500	Tropical Daylight	36	Colour Matching, North Light	33

NOTE: All lm/w efficiency figures in Tables 2 and 3 are very approximate average-through-life values, allowing for ballast losses. Initial net efficiencies for fluorescent lamps are about 30 to 40 per cent. higher.

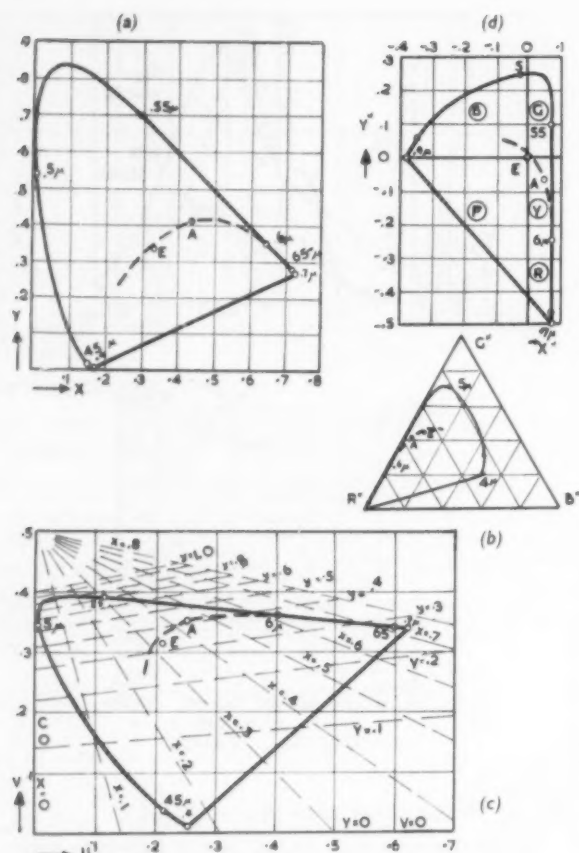


Fig. 5. Chromaticity Diagrams.

Full Curve: Spectral locus (numbers show wavelengths in microns). Broken Curve: Planck locus ($A = 2,854$ deg. K; $E =$ equal energy spectrum, near 5,500 deg. K.)

(a) CIE diagram. Merits: Generally accepted since 1931; X, Y, Z always positive; $z = 0$ for wide range; $y_\lambda = V_\lambda$; E in centre.

(b) Judd UCS: Merits: First UCS diagram.

(c) Mc-Adam—RUCS: Merits: UCS; rectangular; $V = \bar{y}_\lambda = V_\lambda$; simple transformation from CIE.

(d) Breckenridge and Schaub: Merits: UCS; rectangular; division of plane in four colour regions, blue, green, yellow-red, purple; with "E" at zero of co-ordinate system; x'' constant for wide range.

All four diagrams present additive mixtures on straight lines. These UCS systems can be obtained from the CIE system by linear transformation of tri-stimulus values. (See e.g. Murray, Sec. 13.2).

It appears, therefore, that a minimum of five or six fluorescent lamp colours are required in the near-white region. (The usefulness of the 6,500 deg. K high efficiency lamp is dubious.)

(8) "Blended" Light

A well-known principle, older than fluorescent lighting, is blending of lamps with different spectral properties to obtain a combination relatively near to natural daylight. The excess of red radiation from incandescent lamps is, for example, often used to compensate for the absence of red from mercury lamps or the defi-

Table 3
Blended Light

Lamp Combination	Col. Rend.	Initial Cost	lm/w	Application
Large H.P. Mercury + Large Incandescent	Fair	Low	23	Industrial
Mercury/Tungsten Lamp	Fair	Low	18	Industrial
Special Fluorescent + Incandescent Ballast	Quite Good	Low	23	Home, etc.
Std. Fluorescent + Separate large Incandescent	Good	Fairly Low	30	Large Shops, etc.
Blue Fluorescent + Separate Incandescent	Very Good	High	16	Colour Matching

ency of red from high-efficiency fluorescent lamps (see Fig. 4a).

The inherently low efficiency of red radiation applies, of course, to incandescent lamps as well as to any other source. But economics is not merely a matter of lumens per watt. The low initial cost of incandescent lamps makes them still the cheapest red source, and in spite of their wasteful infra-red output and their relatively short lamp life, the combination of large incandescent lamps with high-efficiency fluorescent lamps can have a lower overall cost than a pure fluorescent installation of equal lumen output and corresponding colour rendering properties through the use of "de luxe" lamps.

Table 3 shows some forms of blended light in present-day use.

(9) The CIE System

The CIE psycho-physical system, accepted in all civilised countries, is based on mass observation data. The CIE standard observer has been collated by codifying spectral weighting curves $\bar{x}_\lambda, \bar{y}_\lambda, \bar{z}_\lambda$, which represent his way of seeing colours. (See Fig. 2.)

A three-colour mixture can be presented diagrammatically in a three-dimensional vector space (Ref. Bouma, Murray, etc.). Common practice is to separate quantity and quality, i.e., amount and chromaticity, by defining Chromaticity Co-ordinates: $x = X/(X + Y + Z)$; $y = Y/(X + Y + Z)$; $z = Z/(X + Y + Z)$; whereby $x + y + z = 1$.

It is now possible to represent colour appearance in a two-dimensional graph, either in the shape of a Maxwell triangle or, more commonly now, in Cartesian co-ordinates with y plotted against x , generally called the CIE diagram. (See Fig. 5.)

The full curve shows the spectral locus with blues near the left-hand end, green on top, red near the right-hand end. All real colours are inside this spectral locus. Colours in the vicinity of $x = 1, y = 1$ or $z = 1$ cannot be realised, or one can also say the reference stimuli X, Y, Z are imaginary. The reason for this choice was convenience: no negative values of X, Y, Z can occur.

Other convenient properties of the CIE system are:

(i) Y is identical with luminance, i.e., $\bar{y}_\lambda = V_\lambda$.

The somewhat puzzling corollary is that X and Z

are colour components without luminance, and the XZ plane is called "Alychne."

(ii) The white point corresponding to the equi-energy spectrum lies in the centre of the x, y, z diagram (at $x = y = z = 0.333$).

(iii) $z_\lambda = 0$ over a wide range, practically the long-wave half of the spectrum.

It should be noted, however, that the straightness of the spectral locus over the upper half is not arbitrary. It is common to all additive mixture diagrams and represents the empirical fact that in this region one spectral light can be matched by only two others, e.g., a yellow by a green + red.

(10) UCS Systems

The CIE chromaticity diagram is useful for presenting and specifying colours, for predicting additive colour mixtures, etc., but it has one serious drawback: it misrepresents colour differences, e.g., a certain distance in the blue region may mean a very appreciable colour difference, while the same distance in the green region may seem hardly noticeable.

Equal colour difference per centimetre length in the diagram or a "Uniform Chromaticity Scale" (UCS) is a new requisite, not inherent in an additive mixture diagram. (In considering it we are entering what Schroedinger called "Higher Colour Metrics.")

One can show that if a chromaticity diagram is altered by projective transformation, or a linear transformation of tri-stimulus values, its original chief properties such as predictability of mixtures along straight lines are maintained but its chromaticity scale in various regions can be altered.

A number of UCS diagrams obtained by linear transformation from the CIE system have been proposed (see Fig. 5); the first by D. B. Judd, an equilateral triangle; subsequently RUCS diagrams (Rectangular—UCS), by D. L. McAdam, and another by Breckenridge and Schaub. All of these are only approximations to a UCS system, though much better than the CIE diagram; one can prove that it is impossible to obtain a perfect UCS system by linear transformation from colorimetric systems. More complex transformations have been proposed, but they have little practical utility.

A UCS diagram is preferable to the CIE diagram for presenting colour changes, differences, tolerances, etc.

(11) Surface Colour Systems

The only widely used system which has uniform colour differences is that developed empirically by Munsell, an arts teacher, for surface colours. It has no simple connection with colorimetry, which is the basis of the CIE system. Another surface colour system proposed by Ostwald is partly based on colorimetry. It is amusing that the Munsell system, devised by an artist, is most favoured among scientists to-day, while the Ostwald system of surface colours, proposed by a scientist, is more popular with some colour experts who have an artistic bias.

(12) Presentation and Specification of Lamp Colours

There are a number of methods for presenting and specifying lamp colours (see Table 4). The most complete, in the form of a spectral curve, is difficult to comprehend and assess without considerable experience and expensive to publish.

Table 4
Presentation and Specification of Lamp Colours

Method of Presentation	Information On		Specification
	Colour Rendering	Colour Appearance	
Complete Spectrum	Complete	Complete	By curve, or about 30 figures
C.I.E. Eight Spectral Bands	Adequate	Adequate	By 8 figures
C.I.E. Chromaticity co-ordinates	Misleading	Complete	By 2 figures
Colour Temperature	Misleading	Possibly misleading	By 1 figure

Somewhat easier to specify and adequate for practical purposes is the "Eight-spectral-band-method," whereby the luminances (or energies) in eight bands are stated. (See Fig. 4b.) It is also standardised by the CIE with band limits: 380—420—440—460—510—560—610—660—760 $m\mu$.

Specifying chromaticity by stating x and y gives complete information on the colour appearance and is, for example, perfect for specifying signal colours. It gives, however, no information on colour rendering, since metameric lamps have identical chromaticities, and therefore the same position in the CIE diagram.

A very simple and therefore popular form of lamp colour designation is by stating the "colour temperature." This is, strictly speaking, only meaningful for Planck radiators, but applicable also to lamps metameric with them, i.e., whose chromaticity lies on the Planck locus (broken lines in Fig. 5). The colour temperature of an incandescent lamp gives almost complete information even on its colour rendering; although colour temperature can be applied to describe the appearance of certain fluorescent lamps, its information on colour rendering is misleading and often causes confusion.

(13) Psychological Factors

So far we have dealt with physical aspects and those psychological factors which are measurable, which are practically additive and which could be normalised in a psycho-physical system. In addition, there are psychological aspects which, although qualitatively known, cannot be easily incorporated in a numerical system such as the CIE system. In particular, *adaptation*, *colour-constancy* and *contrast* effects are of vital practical importance.

The sensation caused by a particular light stimulus depends on circumstances, and one and the same stimulus can cause various sensations. As a general rule, the eye, while getting adapted to a particular colour, will gradually perceive it as less saturated, and if another colour stimulus is seen nearby or in rapid succession the sensation is shifted away from the adaptation colour. For instance, a neutral stimulus will appear as a colour complementary to the adaptation colour, i.e., on the opposite side of the neutral point; a stimulus which is complementary to the adaptation colour will appear more saturated. This effect can be observed by looking at the shadow of a coloured light source.

One can make deliberate use of this as every experi-

enced painter knows, e.g., by means of a blue or green background he makes a red flower appear more vivid (simultaneous contrast); or by changing the colour of a stage set suddenly a producer can achieve stark colour effects (successive contrast).

It can also happen inadvertently as when the section of a large room was installed with mellow (pinkish) fluorescent lamps, another section lighted by incandescent lamps appeared outright greenish and the aesthetic result was somewhat doubtful.

"Colour-Constancy" is a fortunate result of perceptual adaptation. It allows us to assess surface colours fairly correctly under different lighting conditions in spite of the fact that the spectral stimulus received by the eye may have varied quite appreciably; a picture looks so similar in daylight and under incandescent lamps that few people are aware of the remarkable physical difference (see Evans Plate X).

(14) Fluorescence

If a substance absorbs ultra-violet or violet radiation and re-emits longer waves in the visible range it is called "fluorescent"; if the re-emission is delayed, we call it "phosphorescent." The most important application is in fluorescent lamps where the mercury arc produces mainly ultra-violet radiation which is converted to light by fluorescent powder on the inside of the glass tube. Spectacular effects can be created by lamps emitting ultra-violet which makes fluorescent paints on persons, posters or scenery shine in vivid colours. Some modern paints contain fluorescent powders as well as ordinary pigments and their unusual luminosity can produce striking effects useful for advertising and similar purposes.

(15) Conclusions

Some of the aspects, especially colour metrics and some of the facts on psychology and perception, have been treated only briefly. They could fill papers of their own. In fact, having looked at some of the complexities of colour and its perception we may be acutely aware of the uncomfortably big gaps in our knowledge. This is not a bad thing. The belief that it is possible to "know all about it" is the privilege of the uneducated. Knowledge has been compared with a sphere: the bigger it grows, the bigger becomes the surface separating it from the unknown, the bigger the Socratic awareness of our own ignorance.

(16) Bibliography

- Bouma, P. J., *Physical Aspects of Colour*. (Philips Techn. Library, Cleaver Hume Press, 1947.)
 Evans, R. M., *An Introduction to Colour*. (Wiley, N.Y., 1948.)
 Judd, D. B., *Colour in Business, Science and Industry* (Wiley, N.Y., 1952.)
 Murray, H. D., *Colour in Theory and Practice*. (Chapman and Hall, London, 1952.)
 Optical Society of America, *The Science of Color*. (Crowell, N.Y., 1953.)
 Wright, W. D., *Measurement of Colour*. (Hilger, London, 1944.)
 Wright, W. D., *Researches on Normal and Defective Colour Vision*. (Kimpton, London, 1946.)

Street Lighting Meeting in Derby

A most successful joint meeting between the Nottingham Centre of the IES and the Midland Section of the APLE—which covers 12 counties—was held in the Assembly Rooms, Derby, on July 3, 1958. It is believed that this meeting is the first of its type arranged by the two organisations, and Mr. I. A. A. Macdonald—who by coincidence is chairman of the IES Nottingham Centre and the APLE Midland Section—presided. The Mayor of the County Borough of Derby (Councillor Mrs. F. Riggott) in opening the meeting paid tribute to the work of both organisations, which had made considerable contributions towards brightening our cities and towns with floodlighting installations and reducing the number of accidents on the roads after dark.

The chairman said the two bodies were very glad to have with them that day Mr. N. F. Marsh (deputy chairman of the East Midlands Electricity Board), Mr. E. B. Sawyer (president of the IES), Mr. Harry Carpenter (president of the APLE) and many representatives of neighbouring local authorities. He also referred to the presence of Mr. D. E. Beard, the chairman-elect of the IES Bath and Bristol Centre, and Mr. L. A. Duxey, a past president of the APLE.

Mr. Marsh in addressing the meeting referred to both the growth and improvement in street lighting during the past ten years. In that period well over 100,000 additional points had been connected to the system of the East Midlands Board—over three times the number that existed in 1948—and said that the number of group A lanterns was now nearly 20 per cent. of the total installed. He went on to compliment the local branches of the Association and Society in pioneering a joint meeting. Both Mr. Sawyer and Mr. Carpenter made similar references to the meeting when the chairman asked them to address the members and visitors, many of whom had come a long way to be present.

The chairman then introduced Ir. I. Hamming, of Eindhoven, and asked him to present his paper dealing with the development of lighting on the Continent since the end of the last war.

Mr. Hamming opened his paper by drawing attention to the trends in indoor and outdoor lighting and indicated the basic differences between the two and the public reaction to them. He illustrated by means of lantern slides the average wattage of lamps installed in various countries and the average consumption of electricity. The various codes of practice adopted by different countries for street lighting were briefly explained and Mr. Hamming stated that it was a matter of regret that there was not greater uniformity in the developments of street lighting, for various countries had gone their own way. By means of an excellent selection of lantern slides he illustrated typical modern installations in practically every country in Europe.

The ensuing discussion was opened by Mr. H. R. Ruff, who complimented the author not only on a most interesting and instructive paper, but also on his excellent command of the English language. A formal vote of thanks to Mr. Hamming was proposed by Mr. Granville Berry (City Engineer and Surveyor of Coventry), the vice-president of the Association and a past chairman of its Midland Section.

Uniformity in London's Street Lighting

The Departmental Committee on Street Lighting, in its Report of 1937, recommended that there should be reasonable uniformity in the lighting of traffic routes and after referring to the difficulty of attaining this under the present system of administration, suggested that responsibility for highway lighting should be confined to large administrative units, with grants in aid.

The extraordinary diversity of the street lighting in London has frequently been remarked upon and following criticisms in Parliament and in the Press, the Association of Metropolitan Borough Engineers and Surveyors, in February, 1955, set up a sub-committee to investigate the practicability of providing a uniform standard of lighting throughout the metropolitan area. This sub-committee went into the matter with some thoroughness and in March, 1956, it submitted a report to the Works Sub-Committee of the Metropolitan Boroughs' Standing Joint Committee, a body established by the Metropolitan Boroughs to advise them on matters of common interest, or those in which joint action may be desirable.

Arising out of this report, the Association's Sub-Committee was asked to prepare "Practice Notes" which would give guidance to London Boroughs on the standard of street lighting desirable in the metropolitan area. These have now been published (price 5s. a copy) by the Standing Joint Committee, at Westminster City Hall, W.C.2, with the title "Practice Notes for Street Lighting in London." They are prefaced with a note stating that "The Standing Joint Committee unanimously concur with the view expressed by the Association of Metropolitan Borough Engineers that the responsibility for street lighting should remain, as at present, under the control of the Borough Councils, the Standing Joint Committee acting as the Central Co-ordinating Authority."

After studying the document it is a little difficult to decide whether this view is the outcome of the committee's work or whether, in fact, the document has been prepared in an attempt to obtain the best from the present administrative arrangements.

The need for co-ordination in the preparation of lighting schemes is strongly emphasised and the absurdity of the present situation is well brought out by the statement that such co-ordination is particularly needful where boundary roads are concerned, "as there should be no division of lighting responsibility along a street where the boundary follows the centre of the road." "The responsibility for street lighting should rest with the Authority which maintains the carriageway."

Technical Recommendations

The "Notes" begin with a table listing the different types of electric light sources which can be used for street lighting and the different wattages which are available in each type. It is mentioned that there are a number of streets, some of them important thoroughfares, which are at present lighted by gas and may continue to be so lighted for some years. Nevertheless the "Notes" have been drawn up mainly with electric sources in mind,

although the general principles apply equally well to both illuminants. An interesting paragraph expresses a strong preference for sodium lighting in the following words: "It has been observed that there is improved richness of contrast and visual acuity under sodium light compared with mercury or tungsten installations of equivalent lumens output. This is believed to be due to the physiological reactions of the eye at the threshold between day and night vision. Of lamps at present available it is recommended that sodium sources should be used in all situations where their monochromatism can be accepted."

High Lumen Output

After mentioning the range of lumens per 100 ft. of roadway (2,600 to 7,000) recommended in the Code of Practice for Traffic Route Lighting, it is pointed out that there are a number of areas in central London, well-known shopping streets and important thoroughfares, where lighting to a considerably higher standard is required. The lumen output per 100 ft. in such roads should be at least 10,000, and in special circumstances may be as much as 30,000. The spacing should not exceed 90 ft. (staggered), and central lamps, either post mounted or suspended on span wires, should be used where necessary. Fluorescent, or possibly colour-corrected mercury lamps are recommended.

(It is interesting to compare these figures with the recommendations made by Mr. H. Hewitt and Mr. R. Stevens in their paper read before the APLE last September [see *Light and Lighting* for November, p. 331]. They mentioned a number of installations in which the lumen output was greatly in excess of the Code values and even went so far as to suggest a new Group in which the range would be 20,000 to 40,000 lumens per 100 ft., with a reduction to 10,000 lumens for half the period of operation.)

Other roads considered to require special treatment are the Outer and Inner Ring Roads and the Radial Roads, listed in an Appendix and shown on a small-scale map at the end of the document. For these "Main Through Routes" it is recommended that the lumen output below the horizontal should be between 6,000 and 10,000 per 100 linear ft. There are many other routes with moderately heavy traffic, most, but not all, of them classified roads, for which the recommendation made might perhaps be best described as "generous Group A lighting." Such roads may be through traffic routes, link roads between main roads, by-pass routes or 'bus routes, and the suggested range of lumen output per 100 ft. is 5,000 to 8,000. It is recommended that all the roads referred to in this paragraph should have sodium lighting except where colour-rendering is of importance; for "sodium lighting is favoured by the motoring public. It has the highest lumen output per watt, and is consequently at present the most economical in current consumption for similar intensities. These factors lead to the conclusion that it would go far towards achieving the desirable improvements in standards, uniformity and efficiency if

it were generally adopted outside the central area on Through Routes and on other streets in the County carrying a heavy volume of traffic."

Side Roads

"The side or unclassified roads in some Boroughs in London are only dimly lit" and it is considered that the limits laid down for such roads in the Code of Practice (Part 2), viz., 600 to 2,500 lumens per 100 ft., are too low for London. A figure of 1,500 is recommended for the lower limit, while the upper may be 4,000, or even more in special circumstances. It is noticeable that, whereas elsewhere in the "Notes" the Code values of mounting height are accepted, here it is stated that if the lighting authority decides to exceed the value of 2,500 lumens per 100 ft. "it will be necessary to increase the mounting height above 15 ft., in order that the maximum value may be obtained from this higher standard of illumination."

Considerable stress is laid on the need for gradation where a side road or a less important thoroughfare joins one with a higher standard of lighting. In particular, it is recommended that any road which joins one of the special thoroughfares referred to earlier should have a transitional length of gradually scaled-down illumination. Similarly "it is suggested that consideration be given to the gradual diminution of street lighting intensity when leaving a road lighted to Group A standard and entering a road lighted to Group B standard. This can be achieved by installing two or three columns in the side road immediately adjacent to the main road with lamps having a progressively diminishing lumen output and possibly a decreasing mounting height."

Maintenance and Other Matters

The importance of good maintenance, properly programmed in relation to local conditions and the type of equipment used, is rightly stressed and attention is drawn to the need for frequent cleaning of traffic signs and bollards. The inspection of main-road lighting and bollards should be carried out nightly within two hours of lighting-up time.

The period of lighting recommended is from 15 minutes after sunset to 15 minutes before sunrise and attention is directed to the fact that certain types of discharge lamps, with a long warming-up time, should be switched on some 25 minutes earlier. On the subject of half-night lighting it is stated that "in the central part of London it is likely that Authorities will decide to maintain full lighting throughout the night. In those Boroughs where lighting standards are reduced on the main roads in the early hours of the morning, full lighting must be maintained at all important junctions. It is most important that the reduced standards adopted should be agreed with neighbouring Boroughs to ensure that such reductions are uniform."

For lighting and extinguishing, the time-switch is considered to have certain disadvantages in London where climatic conditions may give rise to poor visibility during daylight hours and to dark periods in advance of normal lighting-up times. "It is proposed to study the economics of centralised switching either by radio or by injection of electrical impulses through the supply mains; the equipment would serve several Boroughs and any recommendations would include a suitable date for commencement

designed to enable the lighting authorities to make adequate provision for the amortisation of the cost of time switches before the date of the change."

A section of the "Notes" deals with bollards and traffic signs which, although not strictly part of the lighting system, should be planned with it and be included in the general maintenance programme. The point is made that the lighting should not cause glare which, in the case of a sign, may defeat the object by making the message unreadable.

The paragraph on fog lights underlines, by implication, the advantages of central control. Unless this is available manual switching is needed, so that only selected streets can be lighted when the emergency arises. "Where additional lighting is required during foggy weather at busy traffic intersections it is recommended that special fog lamps should be erected and wired separately from the street-lighting system. Arrangements can then be made for them to be switched on and off by the police, or by light-sensitive cells."

Comment

These "Practice Notes" must be welcomed as official recognition of the need for providing the metropolis with lighting of an exceptionally high standard. It is, in fact, stated in the Preamble that "London should set an example to the rest of the country by installing high standards of illumination on its roads." So far, so good, but what about the extraordinary differences between one Borough and another? It is very evident that those responsible for the original report and for the present document are acutely aware that the criticisms on this score, criticisms to which, in fact, they themselves refer, are not without justification. Whether the recommendations they have made will provide a remedy is open to doubt. "It is submitted," they write, "that the best solution to the problem in London is for the responsibility for street lighting to remain as at present, the Standing Joint Committee acting as the Central Co-ordinating Authority," but this appears to be at most a considered opinion and the present document produces no evidence of any kind to support it.

It is difficult to imagine any good technical reason why the lighting of London's streets should be in the hands of 29 different authorities, whatever the efforts made to co-ordinate their activities. Their rateable values per mile of thoroughfare are vastly different and the relative importance attached to the many different services for which each authority is responsible cannot fail to differ widely. The situation is well illustrated by one of the reasons given for the present unsatisfactory state of affairs. "Because of housing needs and other strong claims on local finances, it has not previously been easily possible for Metropolitan Borough Councils to improve their lighting, although many have achieved much progress, and it is understood that a number have street lighting modernisation schemes under consideration." Whatever the extenuating circumstances, the fact remains that the present system has produced a state of affairs which it is no exaggeration to describe as chaotic. It is very doubtful whether the impartial reader of the present document will be convinced that any set of recommendations such as it contains can, without a drastic change in the existing administrative arrangements, provide the remedy which is so urgently required.

SUSTAINING MEMBERS OF THE ILLUMINATING ENGINEERING SOCIETY

The IES has played a major part in the development of better lighting everywhere to the direct benefit of industry. The following is a list of companies and organisations who show their appreciation of the work of the IES by being Sustaining Members of the Society. There are many more firms whose businesses have prospered in no small way because of the work of the IES and who should therefore help to sustain the Society.

A.E.I. Lamp and Lighting Co. Ltd.
J. Aikman and Co., Ltd.
Aladdin Lighting Ltd.
Allom Brothers Ltd.
Arrow Plastics Ltd.
Atlas Lighting Ltd.
Aurora Lamps Ltd.
Barlow and Young Ltd.
T. Beadle and Co., Ltd.
Benjamin Electric Ltd.
City of Birmingham Education Department.
Bolton Corporation Lighting Department.
British Electrical Development Association.
British General Electric Co. (Pty.) Ltd., Johannesburg.
British Luma Co-operative Electric Lamp Society Ltd.
British Optical Association.
British Thomson-Houston Co. (S.A.) (Pty) Ltd.
Cartwright, J. T. and Sons, Ltd.
Chance Bros. and Co., Ltd.
The Cinematograph Exhibitors' Association of Great Britain and Ireland.
Claude Neon Lights of New Zealand Ltd.
E. Clegg and Sons, Ltd.
Courtney, Pope (Electrical) Ltd.
Crompton Parkinson Ltd.
R. and A. G. Crossland Ltd.
Cryselco Ltd.
George Davidson and Co., Ltd.
Hubert Davies and Co., Ltd., Johannesburg.
Dernier & Hamlyn Ltd.
Dominec (Pty.) Ltd., Johannesburg.
Docker Bros.
Dodd and Oulton Ltd.
Dorman and Smith Ltd.
Downes and Davies Ltd.
Eastern Electricity Board.
Eastern Gas Board.
East Midlands Electricity Board
Corporation of the City and Royal Burgh of Edinburgh.
E.G.S. Company Ltd.
Ekco-Ensign Electric Ltd.
Electric Lamp Industry Council
Electric Street Lighting Apparatus Co., Ltd.
Electrical Components Ltd.
Electricity Council.
George Ellison Ltd.
Engineering and Lighting Equipment Co., Ltd.
Engineering Service Installations Ltd.
Erinoid Ltd.
Evans Electro-selenium Ltd.
The Ever Ready Co. (Great Britain) Ltd.
Falk, Stadelmann and Co., Ltd.

Falks Electrical Supplies (S.A.) (Pty.) Ltd., Johannesburg.
H. W. Field and Son Ltd.
Foster Electrical Supplies Ltd.
B. French Ltd.
Fulford Brown Bros. (1929) Ltd.
Gas Council.
General Electric Co., Ltd.
Girdlestone and Co., Ltd.
Donald Grant and Sons Ltd.
Hailwood and Ackroyd Ltd.
Harris & Sheldon (Elec.) Ltd.
W. T. Hellaby and Co., Ltd.
Heyes and Co., Ltd.
S. H. Heywood and Co., Ltd.
Hirst, Ibbetson and Taylor Ltd.
Hivac Ltd.
Holland House Electrical Co., Ltd.
Holophane Ltd.
Humber Ltd.
Hume, Atkins and Co., Ltd.
Imperial Chemical Industries Ltd. (Alkali Division).
Imperial Chemical Industries Ltd. (Metals Division).
Imperial Chemical Industries Ltd. (Paints Division).
Imperial Chemical Industries Ltd. (Plastics Division).
Inductive Appliances Ltd.
J. A. Jobling and Co., Ltd.
A. G. Jorgensen (1956) (Pty.) Ltd.
James Kilpatrick and Son Ltd.
Knightshades Ltd.
Lancashire Dynamo Electronic Products Ltd.
Leeds Education Committee.
Linolite Ltd.
Littlewoods Pools, Central Maintenance Department.
Corporation of Liverpool.
London Electric Firm Ltd.
London Electricity Board.
Joseph Lucas Ltd.
Luminated Ceilings Ltd.
Luxram Electric Ltd.
Marryat and Place Ltd.
Merchant Adventurers Ltd.
Merseyside and North Wales Electricity Board.
Metropolitan-Vickers (S.A.) (Pty.) Ltd., Johannesburg.
Midland Electric Installation Co.
Midlands Electricity Board.
Morgan Crucible Co., Ltd.
Mortimer Gall and Co., Ltd.
Municipal Electricity Department, Singapore.
Neon Fluorescent (S.A.) Ltd., Johannesburg.
Nettle Accessories Ltd.
Newey and Eyre Ltd.
North-Eastern Electricity Board.

North-Western Electricity Board.
North Western Gas Board.
Oldham Corporation Surveyors and Buildings Committee
Oldham and Son Ltd.
Philips Electrical Ltd.
S. A. Philips (Pty.) Ltd., Johannesburg.
F. H. Pride Ltd.
Prudential Assurance Co., Ltd.
Albert E. Reed and Co., Ltd.
Revo Electric Co., Ltd.
Fred Reynolds Ltd.
John Riley and Son (Electrical) Ltd.
J. Rivlin Ltd.
Robinson, King and British Challenge Glazing Co., Ltd.
Rogers, G. S. (Pty.) Ltd., Johannesburg.
Rowe Bros. and Co., Ltd.
Rowlands Electrical Accessories Ltd.
Satchwell and Gittings Ltd.
James Scott and Co., Ltd.
Siemens Brothers British (Pty.) Ltd., Johannesburg.
Siemens Edison Swan Limited
Sign Components Ltd.
Simplex Electric Co. Ltd.
Simplex Electric Co. (S.A.) Ltd., Transvaal.
S.L.R. Electric Ltd.
S.M.D. Manufacturing Co. (Pty.) Ltd., Natal.
Herman Smith Smithlite Ltd.
Wm. Allan Smith and Co., Ltd.
W. H. Smith and Co. (Electrical Engineers) Ltd.
J. G. Sneath Ltd.
South-Eastern Electricity Board.
South of Scotland Electricity Board.
South Wales Electricity Board.
South-Western Electricity Board.
Southern Electricity Board.
Stella Lamp Co. Ltd.
Strand Electric and Engineering Co., Ltd.
Stretford Corporation.
Strong Electric Corporation (Great Britain) Ltd.
Wm. Sugg and Co., Ltd.
Superconcrete Pipes (S.A.) Ltd.
Thermo-Plastics Ltd.
Thorn Electrical Industries (S.A.) Pty., Ltd., Johannesburg.
F. W. Thorpe Ltd.
Troughton and Young, Ltd.
Tucker and Edgar (Tecnee, Ltd.)
Verity's Ltd.
Walsall Conduits Ltd.
J. Walton (Electrical) Ltd.
Wardle Engineering Co., Ltd.
J. M. Webber and Co., Ltd.
Whitworth Electric Lamp Co., Ltd.
Wokingham Plastics Ltd.
A. J. Wright (Electrical) Ltd.
Yorkshire Electricity Board.

The Villa d'Este, Rome

The Villa d'Este at Tivoli, near Rome, is world famous, both for its sumptuously decorated building and for the many elaborate and beautiful fountains which adorn the grounds. An ambitious lighting scheme has recently been installed there and, although this is not yet complete, much of it is in operation and we have received from a correspondent in Milan an illustrated brochure which gives a good idea of the lavish scale on which the installation has been planned. Our illustrations show respectively the "Fountain of the Organ" (Fig. 1), the numerous

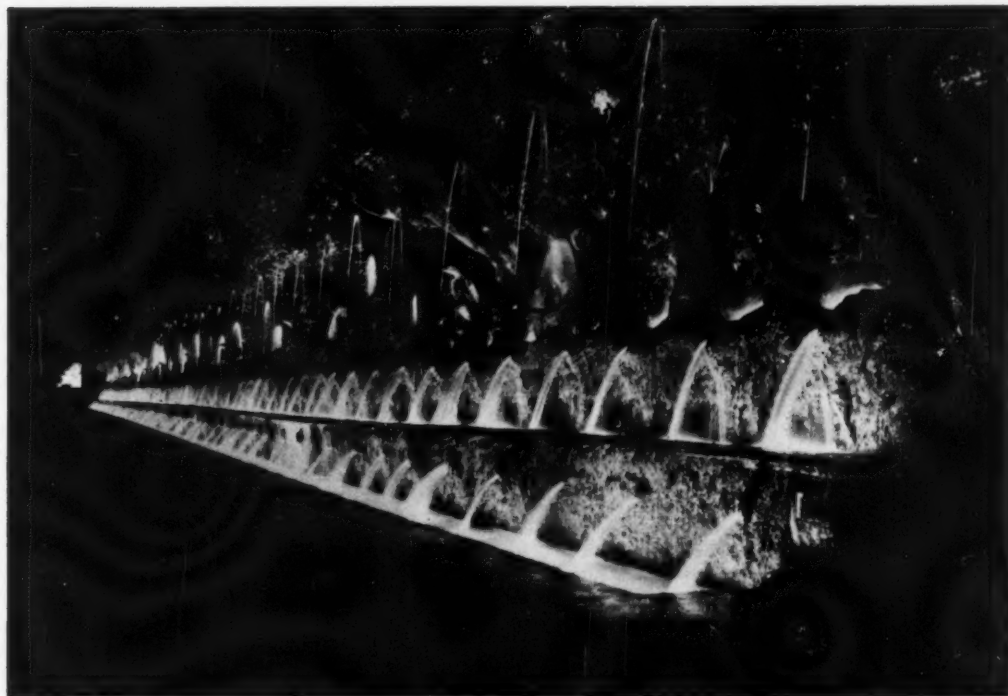


Fig. 1 (left). La Fontana dell'Organo.

Fig. 2 (top right). Le Cento Fontane.

Fig. 3 (bottom right). Salone del Convito degli Dei.

illuminated jets of "The Hundred Fountains" (Fig. 2), and one of the rooms in the Villa, with its magnificently decorated ceiling and walls illuminated entirely from the cornice (Fig. 3). The lighting is entirely by means of tungsten lamps, many of them in projectors of a submersible type; the total load is approximately 300 kw., although provision has been made for a further 150 kw. to allow for possible extensions in the future.



NEW PRODUCTS

New luminous ceiling

A new luminous ceiling, known as the SGB "Glolite" ceiling, designed for speedy installation in both new and existing buildings is now being produced by Scaffolding (Great Britain) Limited.

Channel sections of 5 in. by 1½ in. by 16 gauge mild steel are held by rods hung from the structural ceiling. They support infilling panels which may be in continuous lengths or divided at suitable intervals by noggin pieces of the same section. The luminous ceiling itself is available in two forms. In "Glolite" 1 the channel sections are spaced at



The SGB 'Glolite' 1 ceiling

2 ft. 11½ in. centres and Fibreglass sheets of dogtooth profile are supported on studs fixed to the sides of the channel. In "Glolite" 2, ½ in. by ½ in. mild-steel channel is fixed to the side of the main channel (spaced at 3 ft. centres) to hold a corrugated pvc infill. The channel sections are normally supplied with a priming coat of neutral colour, but may be stove-enamelled at extra cost, if required by the customer. Full details of the new ceiling may be obtained from The Metal Lathing Division, Scaffolding (Great Britain) Limited, Willow Lane, Mitcham, Surrey.

Accessories for vapour-proof fittings

Crompton Parkinson Ltd. have introduced a "Perspex" cylinder for totally enclosing the lamp in fluorescent flame-proof fittings. The cylinders are designed to withstand shocks which might fracture a lamp leading to spoilage of raw materials or injury to personnel; suggested applications are in cold stores or where foodstuffs are processed, in laboratories and mixing plants. Specially designed flanges and rubber gaskets are supplied which completely seal off the tube from the ingress of moisture and dust, etc.

Small bulb filament lamps

Atlas Lighting Limited have now introduced a new range of lamps with very small bulbs for use in contemporary lighting fittings (particularly the multi-arm type) and other applications where small bulb size is desirable. The new lamps—the Atlas "Continental" range—have an internal "Silverlight" finish to give the soft, glare-free light so important in bulbs of this type which are usually used without a shade or diffuser. There are two types of lamp. The first—the "Continental Lamp"—has a 45 mm. diameter spherical bulb and is available in 25-watt and

40-watt ratings. Price of the 25-watt is 2s. 6d. plus 6d. purchase tax, and for the 40-watt, 2s. 9d. plus 7d. purchase tax. The second type—the "Continental Candle"—is a 40-watt candle lamp with a bulb only 35 mm. in diameter, a size usually associated with 25-watt rating. Price of the "Continental Candle" is 3s. 6d. plus 8½d. purchase tax. The new lamps are available in 210/220, 230/240 and 250 voltage ratings. Both types of lamp are available with either SBC or SES caps. The 40-watt candle and spherical bulb lamps are gas filled to give greater efficiency.

280-watt sodium lamp

A new Osram integral sodium lamp rated at 280 watts will be marketed from October 1. The new lamp, which has a light output of 16,800 lumens—comparable with that of the 400-watt mercury lamp—provides 85 per cent. more light than the 140-watt sodium lamp with a separate jacket.

The integral jacket has the same dimensions as the present Osram 140-watt integral lamp and houses two arc tubes, each rated at 140 watts. The new lamp has an efficiency of 60 lm/w throughout an average life of 4,000 hours. Connections are brought out to a 4-pin cap and each arc tube is operated independently from standard 140-watt control gear.

The lamp combines all the advantages of integral construction, which include fully protected arc tubes for reliable starting, easy handling and maintenance and will meet the future demand for higher illumination values for street lighting, while providing economies in power construction and equipment. It is also suitable for introducing into existing installations in which columns are spaced at distances greater than the normal 120 ft. In such instances it may be advantageous to mount the lanterns at a height of about 30 ft. to reduce glare and provide more even illumination.

The list price is £7 18s.

Frontispiece

The picture on page 291 shows one of the private offices in the new offices and showrooms of IBM United Kingdom Ltd. at 101 Wigmore Street, London. The lighting fittings, which were supplied by the GEC Ltd. to the requirements of Mr. Jonathan Green, design consultant to IBM, and Mr. C. H. Elsom, the architect, were designed in relation to the building's proportions and arranged to reduce the apparent intensity of the light-sources. Each fitting houses two 4-ft. 40-watt tubes; the illumination level is 25 lm/ft².

Acknowledgment

Acknowledgment is made to Troughton and Young (Lighting) Ltd., who provided the majority of the illustrations used in the article "Britain at Brussels" in the August issue.

Consultant

Consultant would welcome one or two additional assignments, regular basis or individual projects. Dip.M.I.E.S., A.M.I.Mech.E., Associate I.E.E. All types lighting, mechanical engineering. Product design, factory mechanical/electrical maintenance and expansion. Box 589.

Machinery required

High- and slow-speed hot cathode fluorescent lamp-making machinery required.

Second-hand machines are also considered.

Inter-Continental Exports and Imports, 522 Diagonal Road, Visvesvarapuram, Bangalore 4 (S. India).

Personal

MR. ALBERT H. DE RITTER, a senior lighting sales engineer at the AEI Lamp and Lighting Company's Southern Regional Office at Long Acre, London, has retired after 20 years with AEI. Friends and colleagues in the company gave him a gold wrist-watch and a cheque as a leaving present.

MR. H. B. C. WOODCOCK has been appointed a lamp applications engineer with the Midlands Region of Philips Electrical Ltd., based at Regional Headquarters, Birmingham. Mr. Woodcock received his early training with Siemens Bros. Ltd. and the General Electric Co. Ltd. He later became manager of the Electrical Department of Harris and Sheldon Ltd. Immediately before joining Philips he was for a number of years manager of the Lighting Division of Veritys Ltd.

MR. R. F. MATHIESON is the new chairman of the Electrical Engineers (ASEE) Exhibition Ltd., following the retirement of Mr. J. Flood, who held this post for a number of years. Mr. Mathieson was previously treasurer of the ASEE and has been a member of the Exhibition Company's Organising Committee for some years.

MR. JOHN A. HALL has been promoted to Midland Area Manager in the recently opened branch of Courtney, Pope (Electrical) Ltd. at 254a Corporation Street, Birmingham 4.

Obituaries



Mr. Guy Campbell

Mr. Guy Campbell, recognised as a world-wide leader in the electric lighting industry, and one of the pioneers of the scientific application of lighting, particularly in industry, died on August 4 in his seventy-second year. He was Chairman and Joint Managing Director of The Benjamin Electric Ltd., a position he has held for 47 years. He was also, until 1957, Chairman and Managing Director of Holophane Ltd., and a Director of several other companies during his long career. He was always a staunch supporter of the Illuminating Engineering Society and served on numerous committees associated with the electrical industry. At one time he developed an active and large motor-car accessory and radio component side for his company. He leaves a widow, son and two married daughters. A memorial service will be held at St. Columba's, Pont Street, S.W.1, at 3 p.m. on September 8.

Mr. Moss Mansell

Mr. Moss Mansell, one of the three original Directors of The Strand Electric and Engineering Co. Ltd., died on June 18 in London. Mr. Mansell combined in one man the practical engineer and the man of business, and for many years ran his own firm, Mansell and Ogan, specialising in arc resistances, dimmers and other switching gear. He

joined forces with the late Arthur Earnshaw and Phillip Sheridan in the Strand Electric in due course and remained Works Director until 1936. The magnetic clutch on which the majority of British stage and television lighting remote controls are still based was invented by Mansell in 1929.

Correspondence

Lighting and Seeing

Dear Sir,—I was particularly happy to read the editorial of the last issue of *Light and Lighting* referring to the partnership of Lighting and Seeing, and the further reference to this subject in the current issue of your publication in the "Postscript" by your correspondent Lumeritas.

I think I may confidently say that for some years I have been trying to foster a closer understanding between the professional ophthalmic consultant and the lighting engineer, but the mutual distrust of these factions appears to have been manifest on the basis that each seems to think his particular piece of crust is the whole pie!

I feel that nothing but good can come from a closer co-operation between the two factions, and sincerely trust that your comments will be more sustained in the future than they have been in the past to bring about this desirable state of affairs.

Speaking personally, I must say that I have been surprised time and again that no real encouragement has been given to members of my profession to play their most useful part in the work of illumination, and those of us who are members of the IES are members because of the invitation extended to us by individuals and not by the society as an official body.

The work that I, and many of my colleagues, have undertaken in the industrial sphere of ophthalmic practice have shown us all too plainly on far too many occasions that many lighting installations are good engineering jobs, but do not satisfy the requirements for which, presumably, they were designed, to enable operatives to see comfortably at their individual tasks.

Preston, Lancs.

SYDNEY MOUNTAIN.

Situations

Vacant

Crompton Parkinson Limited require a LIGHTING ENGINEER, Dip.M.I.E.S. preferred, with experience of Industrial and Commercial planning, for London Planning Office. Apply in writing with particulars to Ref: SSV, Crompton House, Aldwych, London, W.C.2.

Rapidly expanding and known firm require REPRESENTATIVES on commission basis to sell fine quality Reproduction French Style Furniture and/or Lighting Fittings. Box 588.

Ekco-Ensign Ltd. require experienced LIGHTING ENGINEER at their Birmingham office. He should have completed National Service and be conversant with modern lighting planning and equipment. Apply Senior Lighting Engineer, 45 Essex Street, Strand, W.C.2.

SENIOR LIGHTING ENGINEER for London Illuminating Engineering Dept., Atlas Lighting Ltd., a Subsidiary of Thorn Electrical Industries Ltd. Apart from normal lighting engineering duties position calls for joint responsibility in administration of Dept. in association with a senior member of present staff. Candidates should be between 28 and 35 and should have minimum qualifications of City and Guilds full Technological Cert. in illuminating engineering together with Ord. National Cert. in electrical engineering. Applications in writing to Staff Dept., Atlas Lighting Limited, 105-109 Judd Street, London, W.C.1.

POSTSCRIPT By 'Lumeritas'

RECOMMENDED levels of illumination are likely to be much discussed in the near future, for new values will be forthcoming from the USA and new values have just been published in the USSR. A preliminary report on the changes contemplated in the USA appeared in the April issue of *Illuminating Engineering*. According to this, a new system of determining the illumination required for different visual tasks has emerged from the researches of Dr. Richard Blackwell, which have been going on for the past eight years. As far as I can gather from what has yet been published, the new data are considered to justify higher recommended values than those now current. Practical application of the new method involves an appraisal of the particular tasks for which prescriptions are required in such a way that their counterparts or equivalents can be found among a standard list of 56 practical visual tasks which have been rated as to difficulty by "actual measurement" using the Blackwell visual task evaluator. From incomplete data on "oculomotor adjustment functions" it is stated that "in all locations involving visual tasks, levels of less than 30 ft.c. do not appear desirable." As to the criteria which the new recommended values of illumination are intended to satisfy, these are said to be: "A. Visual capacity of five assimilations per second (APS). B. 99 per cent. accuracy (maximum practical accuracy). C. Suprathreshold visibility factor of 15." I find A and C rather cryptic but, doubtless, explanations will come in due course. Doubtless, too, all three criteria amount to much the same as our "efficient seeing."

INCIDENTALLY, I have often heard it said that our own IES recommended values of illumination are intended to permit a standard of visual performance equal to 90 per cent. of the maximum that could be achieved under ideal lighting conditions. No statement to this effect is to be found in the IES Code and the idea probably sprang from a paper by H. C. Weston which preceded the post-war IES Code and put forward proposals for it. Actually, our IES recommended values for tasks which are not in the upper classes of the difficulty range are probably sufficient for their almost maximum performance, while the values for the most exacting tasks may not be adequate for such a close approach to maximum efficiency. However, it should be appreciated that the "visual performance" referred to in the IES Code is a compound of two components, namely, speed of discrimination and accuracy of discrimination. Thus, a standard of visual performance of 90 per cent. means that only one of these components can be as low as 90 per cent. Accuracy must be 100 per cent. if speed is only 90 per cent., otherwise the compound performance criterion is not satisfied. If, according to the American report, the maximum practical accuracy is 99 per cent. (this, if true, is true only in the long run), then speed must be about 91 per cent. before visual performance, in our sense of the term, amounts to 90 per cent. But, if speed and accuracy are each equally good, then each has to be practically 95 per cent. of the maximum attainable in order to satisfy the

supposed 90 per cent. criterion (since $0.95 \times 0.95 \times 100 = 90$ per cent. approx.). So, even if our IES Code criterion of visual performance were 90 per cent., this is a more exacting criterion than its face value suggests.

AS TO the range of illumination values covered by the new American proposals, it is recommended that any value selected "be fitted into the . . . sequential order: 10, 15, 20, 30, 50, 70, and $100 \times 0.1, 1, 10, 100, 1,000$ as required." The basic sequence will be recognised readily as that found in scales A and C of the British code, but the multiplying factors to be used "as required" suggest that the full range of values contemplated extends from 1 to 100,000 ft.c.! If the maximum of this range were realised it would give the blackest of black materials a luminance of about 1,000 ft.-lamberts: but if no such maximum is really contemplated, the highest multiplying factor appears to be redundant. Clarification of some of the American proposals may be expected fairly soon, for it is now six months since their first formulation "during two all-night sessions at Dearborn"! Meanwhile, new standards of illumination have been formulated in the USSR and published in the magazine *Svetotekhnika*. Like the American recommendations, those of Russia have been elaborated on the basis of experimental investigations, but there are striking differences between the proposals from East and West as well as some apparently common ground.

THE criterion which the Russian recommendations aim to satisfy is equal visibility for "labour processes of different degrees of precision." Visibility of a task is determined "by the number of contrast thresholds," according to a method due to V. V. Meshkov and, usually, with the aid of the polarisation visibility-meter devised by L. L. Dashkevich. The recommendation of "super-high" levels of illumination is avoided because, although they may allow of finer discrimination, it is said that they fatigue the central nervous system and so reduce working capacity. The basic range of values is covered in 17 steps, the lowest value being 5 lux and the highest 3,000 lux. Most of the grades or categories of visual tasks for which recommended values of illumination are given are defined—like our own—in terms of size and contrast of what has to be seen. But the most novel feature of the code is that for each of the four highest classes of task two sets of values are given; one set refers to incandescent filament lighting and the other set—which is greater by a factor of two—refers to fluorescent lighting. It is said that the researches of Soviet physiologists and lighting engineers (as well as of British, American and French scientists) have revealed a difference in the degrees of visual perception and productivity in conditions of equal brightness achieved by incandescent and by fluorescent light. This is news to me, and no such difference has been shown in the only British and American studies of this kind which are known to me.



eyes right . . .

A few of the many commercial and industrial
fluorescent fittings in the Courtney, Pope range.
For better lighting Courtney, Pope is always a fitting choice

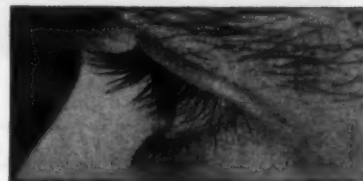
COURTNEY, POPE

The Lighting Specialists

COURTNEY, POPE (ELECTRICAL) LTD
AMHURST PARK WORKS, TOTTENHAM, LONDON N15
STAMFORD HILL 1270 (Fifteen Lines)

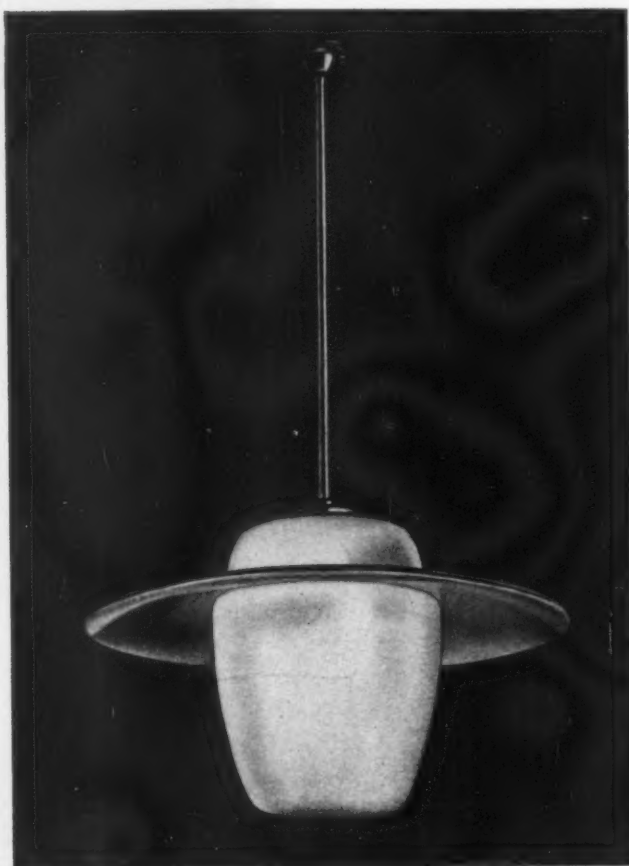
Branches:

Chatham Buildings, 10 Chatham Street, Piccadilly, Manchester 1. Central 1837
254a Corporation Street, Birmingham 4. Central 5852



"Hailware"
REGD.

**MODERN
REFLECTOR
FITTING**



*SEND
FOR
DETAILS*

HAILWOOD & ACKROYD LTD
18, LOWNDES STREET · LONDON · S.W.1.

Telephone: Sloane 0471.



atlas display lighting



*W. H. Smith exhibit at the World Fair, Brussels—
illustrating a typical use of Atlas display lighting.*

Successful display lighting requires, above all, flexibility within the lighting system. It is this quality which is a predominant feature of Atlas

Display Lighting fittings. From four basic units and half a dozen attachments some fifty fittings can be assembled, suitable for surface or recessed mounting, with horizontal or vertical lamps, in ratings from 60 - 500 watts. The attachments include deep and shallow satin etched bowls, a white metal louvre, clear or pearl stepped lens, a glass 'festival' diffuser and a selection of Cinabex colour filters. A unique Soffit ring (illustrated above) clips into position hiding all fixing screws and carrying the attachments. A number of additional fittings designed for special display lighting jobs complete this range of fine quality Atlas fittings. Atlas Lighting engineers are keen to help you with your lighting problems. Their advice is free!

Please ask for one to call.

ATLAS LIGHTING LIMITED. A subsidiary company of Thorn Electrical Industries Limited.
255 SHAFTESBURY AVENUE, LONDON, W.C.2.



Osram the

GUARANTEED

Tube

A free replacement will be given for any standard straight Osram tube which fails under normal service conditions before 3,000 hours or one year of use, whichever is the shorter.

This guarantee covers all Osram Tubes from
1½ ft — 8 ft, 15 w — 125 w.

Unique manufacturing processes are used in making Osram guaranteed tubes. These techniques are designed to eliminate early failures and ensure superb maintenance of lighting efficiency throughout a long life.

Osram

Guaranteed Tubes
for trouble-free lighting

EKCO

*fit for
the finest
company*



EKCO Fluorescent Lighting fittings are designed by specialists.

With a wide range of modern diffusers, they are ideally suited for use in shops, offices, theatres, public buildings, schools and in the home. These fittings are constructed only of the finest materials and harmonize discreetly with the best modern interior decorations. They are described fully in the recently published EKCO Lighting Catalogue. Write for your copy today.

**Have you
a lighting
problem?**

Then the EKCO Lighting Advisory Service is available to assist you. There is an office in your vicinity. So ask us to send a qualified lighting engineer to discuss your problem on the spot. There is no obligation and the service is entirely free.

EKCO

Lighting Fittings

Switch *brightly* to

EKCO

EKCO-ENSIGN ELECTRIC LTD., 45 ESSEX STREET, STRAND, LONDON, W.C.2. Tel: CITY 8951

SALES OFFICES, ILLUMINATING ENGINEERING DEPTS., SHOWROOMS AND DEPOTS

SOUTHERN: 45 Essex Street, London, W.C.2

Tel: City 8951

NORTHERN: Blackett St., Fairfield St., Manchester 12. Tel: Ardwick 4661

MIDLANDS: 68 Caroline Street, Birmingham 3.

Tel: Central 2997

E. MIDLANDS: 27 High Pavement, Nottingham.

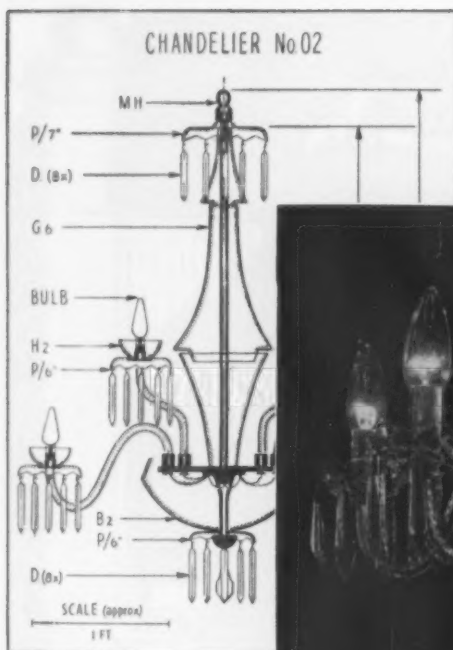
Tel: N'ham 53183/4

SCOTTISH: 26 India Street, Glasgow, C.2.

Tel: Central 2012

SOUTH WALES: 50 Bridge Street, Cardiff.

Tel: Cardiff 33803/4



Waterford Chandeliers



Beautifully hand cut from full lead crystal, Waterford Chandeliers are available in sizes suitable for modern interiors.

Chandeliers can be supplied from stock in original Waterford designs or in new designs in the highest Waterford tradition.

Waterford Glass are also glad to make up chandeliers to architects' own specifications. Particulars of this service will be sent on request.

WATERFORD GLASS LIMITED, WATERFORD, IRELAND
Enquiries for Britain, Australia and New Zealand should be directed to the Sole Agents
J. WUIDART & CO. LTD., 15 RATHBONE PLACE, LONDON, W.1

Waterford Glass

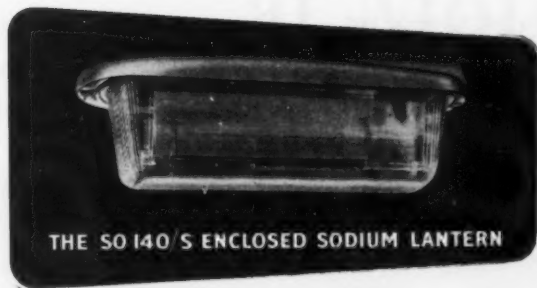


C. M. CHURCHOUSE LTD.
CLARENDON CROSS
LONDON W.11
Telephone PARK 5666-7-8

WRITE FOR CATALOGUE NO. 170



**If you are
thinking about
Street Lighting**



THE SO 140/S ENCLOSED SODIUM LANTERN

then don't forget **★ PERFORMANCE**
that we make the **★ APPEARANCE**
BEST fittings for **★ and GOOD SERVICE**

PHOSWARE

PHOSCO LTD. OF WARE
Phone: Ware 449



BRITAIN'S BEST
SHOCK ABSORBER

PROTECTAFIL

Over quarter of a million in use

Approved by the Arts Council of Industrial Design, British Electricity Authority, Australian Electricity Approval Board.

Specify **PROTECTAFIL** in your Street Lighting Fittings.

The Protectafil damps down both high and low frequency Vibration thereby protecting the delicate lamp filament from early damage. Saves many times its cost.

VIBRATION — WHAT DOES IT COST YOU?

One aspect of industrial lighting which does not always receive its due consideration is that of lamp suspension, with the consequent frequent failure of lamps through vibration. Many thousands of pounds sterling are unnecessarily spent each year in lamp replacements.

Fit **PROTECTAFIL**

Britain's best **ANTI-VIBRATOR LAMP FITTING**

★ Write for Catalogue L, and sample Protectafil.

J. E. WILDBORE LTD

6-12 PETER STREET, OLDHAM

Telephone: MAIN 4475

Established 1908

— 50 YEARS LIGHTING SERVICE —

Centrifugally spun Concrete lighting columns



J. KENYON HUNT
Surveyor, Disley

HIGHWAY "X" WITH "PHOSWARE" SO.140 LANTERN

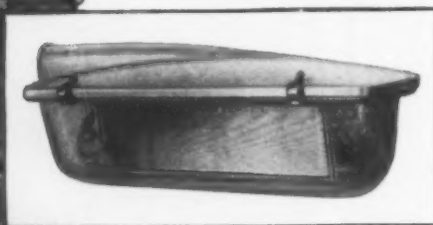
CONCRETE UTILITIES LTD.

HEAD OFFICE & WORKS . WARE . HERTS. . Ware 449
WORKS AT LIVERPOOL . CARDIFF . NEWCASTLE

WARDLE LANTERNS

**the difference between
average and optimum
lighting . . .**

Since the first days of sodium street lighting Wardle lanterns have been used in many major installations. Over 40 years' experience in public lighting is embodied in the manufacture and design of the 'Atholl' which will give you many years of trouble-free service and better than average illumination for lower overall costs. . . .



WARDLE "ATHOLL" For Group "A" lighting

- For 85/140w sodium lamps.
- Lamp operating control gear may be housed in lantern.
- Cast aluminium alloy body and bow ring.
- "Perspex" bowl refractor with smooth surfaces for easy cleaning.
- Resilient gaskets fitted for positive sealing against damp and dirt.

Stove enamelled: white inside, aluminium outside.

THE WARDLE ENGINEERING CO. LTD.

OLD TRAFFORD, MANCHESTER, 16
Telephone: TRAfford Park 1801 (3 lines)

London Office: 34 Victoria Street, S.W.1 Tel: ABBey 4072 Or 1356



W3986

INDEX TO ADVERTISERS

	Page
A.E.I. Lamp and Lighting Co. Ltd.	x
Atlas Lighting Ltd.	xxiii
Benjamin Electric Ltd.	iv
British Lighting Council	cover iv
Cayson Electrics Ltd.	xiv
C. M. Churchouse Ltd.	xxvi
Concrete Utilities Ltd.	xxvii
J. and G. Coughtrie Ltd.	vi
Courtney Pope (Electrical) Ltd.	xxi
Cryselco Ltd.	xi
Engineering and Lighting Equipment Co. Ltd.	298
Ekco-Ensign Electric Ltd.	xxv
General Electric Co. Ltd.	xvi, xxiv
Gowshall Ltd.	xii
Hailwood and Ackroyd Ltd.	xxii
Harris and Sheldon (Electrical) Ltd.	xiii
Holophane Ltd.	cover i
Imperial Chemical Industries Ltd. (Plastics Division)	xx
Inductive Appliances Ltd.	xviii
Lumalampan AB.	xix
Merchant Adventurers Ltd.	xvii
Philips Electrical Ltd.	ii, iii
Phosco Ltd.	xxvii
Revo Electric Co. Ltd.	cover iii
Rotaflex (Gt. Britain) Ltd.	xv
Siemens Edison Swan Ltd.	i
S.L.R. Electric Ltd.	xviii
Stanton Ironworks Co. Ltd.	cover ii
Stewarts and Lloyds Ltd.	ix
F. W. Thorpe Ltd.	xiv
Tube Lamination and Engineering Ltd.	viii
Venner Ltd.	vii
Wardle Engineering Co. Ltd.	xxviii
Waterford Glass Ltd.	xxvi
J. E. Wildbore Ltd.	xxvii
Wokingham Plastics Ltd.	v

Published by THE ILLUMINATING ENGINEERING PUBLISHING COMPANY LIMITED, at 32 Victoria Street, London, S.W.1. Printed by ARGUS PRESS LIMITED, Temple Avenue, and Tudor Street, London, E.C.4, England.

New **REVO** floodlighting at Molineux

This action photograph showing Wolves playing Real Madrid under the new floodlighting was taken at 1/50 sec. at an aperture of f.11—i.e., a normal daylight exposure.



After exacting tests with floodlights of varied makes, Revo equipment was chosen to provide Wolverhampton with the finest football-ground floodlighting system in the country.

The four 146 ft. towers each support 48 Revo floodlights fitted with silvered-mirror reflectors and using Tungsten Filament Lamps, giving a total floodlighting load of 330 Kw. Facilities have been provided to increase the number of floodlights per tower to 60, giving a total load of 415 Kw.

Revo equipment has been specified for some of the most important installations of public and industrial lighting throughout the world, and the Wolverhampton Wanderers Football Club scheme is yet another example testifying to the high quality and efficiency of Revo products.

REVO ELECTRIC COMPANY LTD., TIPTON, STAFFS.

Telephone: TIPTON 2828.

Telegrams: REVO, TIPTON.

Branches at London, Glasgow, Manchester, Newcastle-on-Tyne, Cardiff, Leeds, Belfast, Dublin.





Britain is changing

Illustration: The Wiggins Teape building near St. Paul's Cathedral in London. Modern but with a strong traditional bias, this office block has concealed exterior lighting above the windows to give it as strong an identity by night as by day.

Architects: Treherne and Norman Preston and Partners.

Britain today is changing. Everywhere the bomb-sites are disappearing, out-of-date property is being demolished, and tradition is merging with the cosmopolitan influences of present-day world architecture. There is enormous scope for lighting development to keep pace with the ever-increasing standards being adopted by leading designers, for excellent though many new installations are, the fringes of the progress that could now be made have really only just been touched.

By today's standards, how many homes are really well lit? How many factories have lighting conditions planned for production and welfare rather than for economy? How many shops outside our town and city centres are really letting lighting help them as it should? The fact is that many installations considered good ten years ago are now a long way behind the times, and the same again will happen in less than ten years from now. Lighting development from every point of view has room to stretch and grow to the benefit of all concerned.

The lighting industry is a great one, full of hope and promise, and the British Lighting Council intends to do everything in its power to bring better lighting to the millions for whom it can create a fuller and better way of life.

THE BRITISH LIGHTING COUNCIL LTD. ★ 2 Savoy Hill, London, WC2

